FINAL DRAFT

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT

WOMAN CREEK PRIORITY DRAINAGE
(Operable Unit No. 5)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

March 1991

22506E/R1.TS 03-06-91/RPT

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LIST OF ACRONYMS

The following is a list of acronyms used throughout this work plan.

ACL	Alternative Concentration Limit
AEC	Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
BCF	Bioconcentration Factor
BNA	Base-neutral acid extractable organics
BRAP	Baseline Risk Assessment Plan
CAD	Corrective Action Decision
CCR	Colorado Code of Regulations
CDH	Colorado Department of Health
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMP	corrugated metal pipe
CMS	corrective measures study
CRP	community relations plan
CWA	Clean Water Act
DOE	Department of Energy
DQO	data quality objective
EEP	Environmental Evaluation Plan
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ER	environmental restoration
ERDA	Energy Research and Development Administration
FIDLER	Field Instrument for Detection of Low Energy Radiation
FS	feasibility study
FSP	field sampling plan
GAC	granular activated carbon
GC	gas chromatograph
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HSP	Health and Safety Plan
HSU	Hydrostratigraphic unit
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
IRIS	Integrated Risk Information System
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MSL	mean sea level
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System

PARCC	precision, accuracy representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PID	photoionization detector
QAA	Quality Assurance Addendum
QA/QC	Quality Assurance/Quality Control
QAPjP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFEDS	Rocky Flats Environmental Database System
RFI	RCRA facility investigation
RI	remedial investigation (CERCLA)
ROD	Record of Decision
SAS	Special Analytical Services
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SID	South Interceptor Ditch
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SOPA	Standard Operating Procedure Addendum
TAL	target analyte list
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethylene
TCL	target compound list
TDS	total dissolved solids
TIC	tentatively identified compounds
TOC	total organic carbon
UV	ultraviolet
VOA	volatile organic analysis
VOC	volatile organic compounds
WQC	Water Quality Criteria
WQCC	Water Quality Control Commission

This document presents the work plan for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Woman Creek drainage (Operable Unit Number 5) at the Rocky Flats Plant, Jefferson County, Colorado. This work plan includes a field sampling plan (FSP) that presents the investigation planned to evaluate the presence or absence of contamination at Individual Hazardous Substance Sites (IHSSs) within the Woman Creek drainage. The FSP developed in this work plan is based on the requirements of the Interagency Agreement (IAG) amongst the Department of Energy, Environmental Protection Agency, and the State of Colorado Department of Health. Ten IHSSs are located in Operable Unit Number 5 (OU5). They are the Original Landfill (IHSS 115), the Ash Pits (IHSSs 133.1-133.4), the Incinerator (IHSS 133.5), the Concrete Wash Pad (IHSS 133.6), Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), and the Surface Disturbance (IHSS 209). A second area of surface disturbances south of the Ash Pits has been identified and included in this work plan.

Section 1.0 of this work plan presents introductory information and a general characterization of the region and plant site. In addition, the regional geology and hydrology at Rocky Flats are discussed. Section 2.0 presents descriptions of the site physical characteristics, histories and previous investigations, available information concerning the nature and extent of contamination, and conceptual models for each of the ten IHSSs based on existing data. This initial characterization forms the basis for establishing data needs, data quality objectives (DQOs), and developing an FSP for each IHSS. Section 3.0 presents applicable or relevant and appropriate requirements (ARARs) developed for OU5. Section 4.0 establishes data needs and DQOs considering site characteristics and conceptual models of each IHSS in OU5. Section 5.0 outlines RFI/RI tasks to be performed. Section 6.0 presents the schedule for these tasks. A Field Sampling Plan, based on the requirements of the IAG, is presented in Section 7.0 to satisfy the data needs and DQOs identified in Section 4.0. The Baseline Risk Assessment Plan (BRAP) and Environmental Evaluation Plan (EEP) are presented in Sections 8.0 and 9.0, respectively. A Quality Assurance Addendum (QAA) and Standard Operating Procedure Addenda (SOPA) are presented in Sections 10.0 and 11.0, respectively. A list of references is presented in Section 12.0.

The initial step in the development of the OU5 RFI/RI work plan was a review of existing information. Available historical and background data for each IHSS were collected through a literature search and a review of the Rocky Flats Environmental Database System (RFEDS). Only a few limited investigations have been conducted at OU5 in the past. These investigations include a gamma radiation survey at the Original Landfill (IHSS 115), limited sediment sampling in Woman Creek, ongoing surface water, groundwater and sediment sampling programs along Woman Creek and the South Interceptor Ditch (SID), and Plant-wide air quality monitoring.

Data quality objectives have been developed for this Phase I investigation. DQOs are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI. The DQO process is divided into three stages. Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving these goals.

After assessing the existing information for OU5, the following objectives of the Phase I RFI/RI have been identified:

- Characterize the physical and hydrogeologic setting of the IHSSs
- Assess the presence or absence of contamination at the sites
- Characterize the nature and extent of contamination at the sites, if present
- Support the Phase I Baseline Risk Assessment and Environmental Evaluation

Within these broad objectives, site-specific data needs have been identified based on preliminary identification of contaminant-specific ARARs for OU5 and data needs for the Phase I Baseline Risk Assessment and Environmental Evaluation. The FSP presented in this work plan is based on the data needs and the requirements of the IAG. The FSP for each IHSS requires a combination of screening activities, sampling of soils, sediment and surface water, and well installation and sampling. Site-specific FSPs are briefly summarized below.

IHSS 115 - Original Landfill. Screening activities at the Original Landfill will consist of a review of the gamma radiation survey recently completed and completion of a soil gas survey. Sampling will include subsurface sampling in borings, and sediment and surface water sampling adjacent to the unit. Wells will be installed and sampled downgradient of the unit and in selected soil borings if a plume is encountered. An additional activity at the unit will be a study of the pipes protruding from the landfill and sampling of effluent from the pipes, if present.

IHSS 133.1-6 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad. A radiological survey will be the screening activity conducted at the IHSS 133 sites. Surface soil samples will be collected from the locations that have high radiation concentrations identified during the radiological survey. Subsurface samples will also be collected from borings in the Ash Pit areas. Three monitoring wells will be installed downgradient of the units and sampled.

IHSS 142 - Detention Ponds - C-Series. Surface water samples will be collected from several locations in each pond. Sediment samples will be collected in the ponds, as well as along the entire Woman Creek drainage within the Rocky Flats Plant. Sediment samples will also be collected in the SID. Background surface water and sediment samples will be collected west of the plant. Two monitoring wells will be installed and sampled in the alluvium downgradient of each dam at Ponds C-1 and C-2.

IHSS 209 - Surface Disturbance Southeast of Building 881 and Surface Disturbances South of the Ash Pits. Visual inspections of the surface disturbance areas and reviews of historical use information pertaining to these sites will be completed prior to screening and sampling activities. A radiological survey will be completed at each area. Surface soil samples will be collected from the three excavations at IHSS 209 and from the north-south excavation at the surface disturbance south of the Ash Pits. A sediment sample and surface water sample (if water is present) will be collected from each of the former pond areas at IHSS 209. Surface and subsurface samples will be collected from borings in the parallel excavations and the east and west areas at the surface disturbance south of the Ash Pits.

Data collected during the Phase I Woman Creek drainage RFI/RI will be incorporated into the existing RFEDS database. These data will be used to better define site characteristics, source characteristics, and the nature and extent of contamination; to support the baseline risk assessment and environmental evaluation; and to evaluate potential remedial alternatives. An RFI/RI report will be prepared summarizing the data obtained during the Phase I program and containing the Phase I Baseline Risk Assessment and Environmental Evaluation.

1.0 INTRODUCTION

This document presents the work plan for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Woman Creek Drainage (Operable Unit Number 5) at the Rocky Flats Plant, Jefferson County, Colorado. In this work plan, the existing information is initially summarized to characterize Operable Unit Number 5 (OU5) and a field sampling program is presented to assess potential contamination of the ten Individual Hazardous Substance Sites (IHSSs) that have been identified along or within the Woman Creek drainage. These IHSSs include the Original Landfill (IHSS 115), the Ash Pits (IHSS 133.1-133.4), the Incinerator (IHSS 133.5), the Concrete Wash Pad (IHSS 133.6), Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), and Surface Disturbance (IHSS 209). An additional area of surface disturbances south of the Ash Pits has been included in this OU5 work plan. The Phase I RFI/RI will be conducted in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (U.S EPA 1988a) and Interim Final RCRA Facility Investigation (RFI) Guidance (U.S. EPA 1989a). The data generated will be used to begin developing and screening remedial alternatives and to evaluate the need for further studies for the 10 IHSSs in OU5. The data will also be used to estimate the risks to human health and the environment posed by each hazardous substance site.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions currently in progress at the Rocky Flats Plant. These investigations are pursuant to the U.S. Department of Energy (U.S.DOE) Environmental Restoration (ER) Program [formerly known as the Comprehensive Environmental Assessment and Response Program (CEARP)]; a Compliance Agreement among DOE, the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) dated July 31, 1986; and an Interagency Agreement (IAG) among DOE, EPA, and CDH, dated January 22, 1991. The IAG addresses RCRA and CERCLA issues and has been integrated with the ER Program. In accordance with the IAG, the CERCLA terms "Remedial Investigation" and "Feasibility Study" in this document are considered equivalent to the RCRA terms "RCRA Facility Investigation" and "Corrective Measures Study".

1.1 ENVIRONMENTAL RESTORATION PROGRAM

The ER Program is designed to investigate and clean up contaminated sites at DOE facilities. This ER Program being implemented is organized into five major activities. Activity 1 has already been completed at Rocky Flats Plant (U.S. DOE 1986a). This work plan is part of the Activity 2 program currently in progress for OU5 (Woman Creek drainage).

- Activity 1 - Installation Assessment includes preliminary assessments and site inspections to assess potential environmental concerns.

- Activity 2 - Remedial Investigations include planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites, evaluate potential contaminant migration pathways, and perform baseline risk assessments.

- Activity 3 - Feasibility Studies evaluate remedial alternatives and develop remedial action plans to mitigate environmental problems identified as needing correction in Activity 2.

- Activity 4 - Remedial Design/Remedial Action includes design and implementation of site-specific remedial actions selected on the basis of Activity 3 Feasibility Studies.

- Activity 5 - Compliance and Verification implements monitoring and performance assessments of remedial actions and then verifies and documents the adequacy of remedial actions carried out under Activity 4.

1.2 WORK PLAN SCOPE

Existing information on OU5 was obtained from numerous sources for use in work plan preparation. Section 1.0 of this work plan presents introductory information and a general characterization of the region and plant site. In addition, the regional geology and hydrology at Rocky Flats are discussed. Section 2.0 presents descriptions of the site physical characteristics, histories and previous investigations, available information concerning the nature and extent of contamination, and conceptual models for each of the ten IHSSs based on existing data. This initial characterization forms the basis for establishing data needs, data quality objectives (DQOs), and developing an FSP for each IHSS. Section 3.0 presents applicable or relevant and appropriate requirements (ARARs) developed for OU5. Section 4.0 establishes data needs and DQOs considering site characteristics and conceptual models of each IHSS in OU5. Section 5.0 outlines RFI/RI tasks to be performed. Section 6.0 presents the schedule for these tasks. A Field Sampling Plan, based on the requirements of the IAG, is presented in Section 7.0 to satisfy the data needs and DQOs identified in Section 4.0. The Baseline Risk Assessment Plan (BRAP) and Environmental Evaluation Plan (EEP) are presented in Sections 8.0 and 9.0, respectively. A Quality Assurance Addendum (QAA) and Standard Operating Procedure Addenda (SOPA) are presented in Sections 10.0 and 11.0, respectively. A list of references is presented in Section 12.0.

1.3 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

1.3.1 Site Background and Plant Operations

The Rocky Flats Plant is a government-owned and contractor-operated facility that is part of the nationwide nuclear weapons production complex. The Plant was operated for the U.S. Atomic Energy Commission (AEC) from the Plant's inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the Plant was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by the DOE in 1977. Dow Chemical USA, an operating unit of the Dow Chemical Company, was the prime operating contractor of the facility from 1951 until June 30, 1975. Rockwell International succeeded Dow Chemical USA from July 1, 1975 to January 1, 1990, when EG&G Rocky Flats, Inc. succeeded Rockwell International.

The Rocky Flats Plant's primary mission is to produce metal components for nuclear weapons. These components are fabricated from plutonium, uranium and nonradioactive metals, principally beryllium and stainless steel. Parts made at the Plant are shipped elsewhere for final assembly. When nuclear weapons are determined to be obsolete, components of the weapons fabricated at the Plant are returned for special processing to recover plutonium and americium. Other activities at the Rocky Flats Plant include research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes are generated in these research and production processes. Current waste handling practices involve on-site and off-site recycling of hazardous materials, on-site storage of hazardous and radioactive mixed wastes, and disposal of solid radioactive materials at another DOE facility. However, historically, Rocky Flats Plant operating procedures included both on-site storage and disposal of hazardous and radioactive wastes. Preliminary assessments under the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination.

1.3.2 Previous Investigations

Various studies have been conducted at the Rocky Flats Plant to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the environment. The investigations are referenced in numerous reports including EG&G 1991a.

In 1986, two major investigations were completed at the plant. The first was the ER Program Installation Assessment (U.S. DOE 1986a), which included analyses and identification of current operational activities, active and inactive waste sites, current and past waste management practices, and potential environmental pathways through which contaminants could be transported. A number of sites were identified that could potentially have adverse impacts on the environment. These sites were designated as Solid Waste Management Units (SWMUs) (renamed Individual Hazardous Substance Sites (IHSSs) in the January 22, 1991 IAG) by Rockwell International (1987) and were divided into three categories:

1. Hazardous waste management units that will continue to operate and need a RCRA operating permit.

2. Hazardous waste management units that will be closed under RCRA interim status.

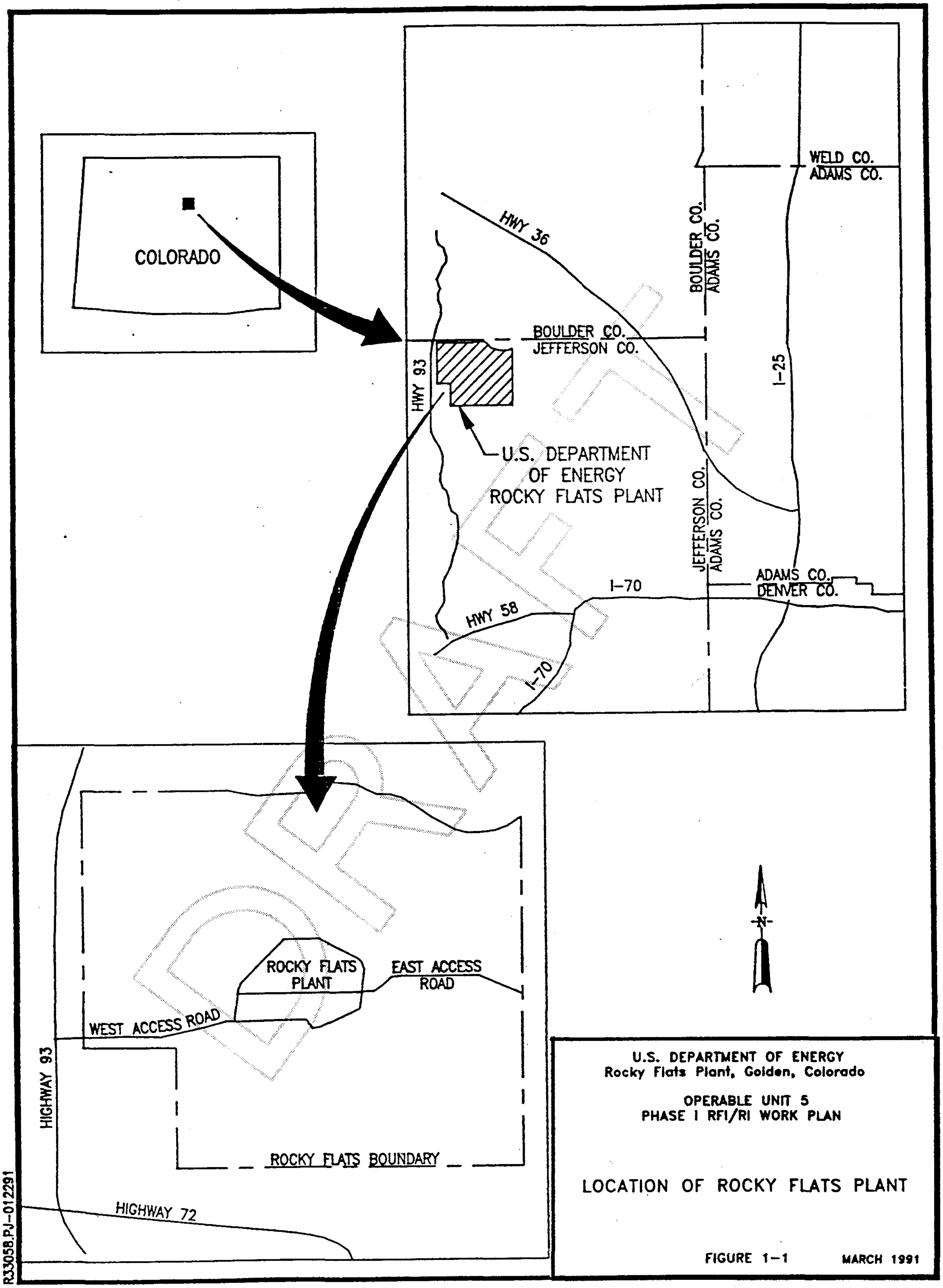
3. Inactive waste management units that will be investigated and cleaned up under Section 3004(u) of RCRA or under CERCLA. No RCRA or CERCLA regulatory distinction in the use of the terms "site," "unit," "SWMU," or "IHSS" is intended in this document.

The second major investigation completed at the Plant in 1986 involved a hydrogeologic and hydrochemical characterization of the entire plant site. Plans for this study were presented in Rockwell International publications 1986b and 1986c, and study results were reported in Rockwell International publication 1986d. These investigations identified the ten IHSSs that are included in OU5 based on their location adjacent to Woman Creek.

1.3.3 Physical Setting

The Rocky Flats Plant is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 1-1). Other surrounding cities include Boulder, Westminster, and Arvada, which are located less than 10 miles to the northwest, east and southeast, respectively. The plant consists of approximately 6,550 acres of federal land and occupies Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th principal meridian. Major plant buildings are located within a plant security area of approximately 400 acres. The security area is surrounded by a buffer zone of approximately 6,150 acres.

The plant is bounded on the north by Colorado State Highway 128. To the east is Jefferson County Highway 17, also known as Indiana Street; to the south are agricultural and industrial properties and Highway 72; and to the west is Colorado State Highway 93 (Figure 1-2).



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION OF ROCKY FLATS PLANT

FIGURE 1-1 MARCH 1991

1.3.3.1 Topography

The natural environment of the Plant and vicinity is influenced primarily by its proximity to the Front Range of the Rocky Mountains. The plant site is located directly east of the north-south-trending Front Range, located about 16 miles east of the Continental Divide. The Rocky Flats Plant is located on a broad, eastward-sloping system of coalescing alluvial fans. These fans, created by the erosion of the Front Range, extend approximately 5 miles to the east, where they terminate in low, rolling hills. The Plant is at an elevation of approximately 6,000 feet above mean sea level (msl). The Plant security area is located near the eastern edge of the fans on a pediment between stream-cut gullies or arroyos (North Walnut Creek and Woman Creek) (Figure 1-2).

1.3.3.2 Surface Water Hydrology

Three streams drain the Rocky Flats Plant with flow generally from west to east. These drainages are Rock Creek, Walnut Creek, and Woman Creek (Figure 1-2). Rock Creek drains the northwestern corner of the plant and flows northeast through the buffer zone to its off-site confluence with Coal Creek. An east-west trending interfluve separates the Walnut Creek and Woman Creek drainages. North Walnut Creek, South Walnut Creek, and an unnamed tributary drain the northern portion of the Plant security area. These three forks of Walnut Creek join in the buffer zone and flow to Great Western Reservoir, approximately 1 mile east of the confluence. Woman Creek drains the southern Rocky Flats Plant buffer zone, flowing eastward to Standley Lake Reservoir and Mower Reservoir. The South Interceptor Ditch is a ditch that flows intermittently and lies between the Plant and Woman Creek. The South Interceptor Ditch collects runoff from the southern Plant facilities and diverts it to Pond C-2, where it is monitored in accordance with the Plant's National Pollutant Discharge Elimination System (NPDES) permit.

1.3.3.3 Climate

The climate in the area of the Rocky Flats Plant is semi-arid, characterized by warm summers and dry, cool winters, as is typical of much of the central Rocky Mountain Region. However, the elevation of the plant (6,000 feet) and the nearby slopes and canyons of the Front Range modify the regional climate. Winds, although variable, are predominantly from the west-northwest, with stronger winds occurring during the winter. The canyons along the Front Range tend to channel the flow during both upslope and downslope conditions, especially when there is strong atmospheric stability. The area occasionally experiences chinook winds with gusts over 100 miles per hour. Rocky Flats meteorology is strongly influenced by the diurnal cycle of mountain and valley breezes. Two dominant flow patterns exist, one during daytime conditions, and one at night. During daytime hours as the earth heats the mountains receive more direct sunlight than the plains and valleys. The result is a general trend for the air flow to travel toward the higher elevations (upslope). The general air flow pattern during upslope conditions for the Denver area is typically north to south with the flow moving up the South Platte River Valley and then entering the canyons into the Front Range. After sunset the air against the mountain side is cooled and begins to flow toward the lower elevations (downslope). The pattern for the Denver area during downslope is flow moving, down the canyon of the Front Range into the Plains. This flow converges with the South Platte River Valley flow moving toward the north-northeast.

Temperatures at Rocky Flats are moderate. On the average, daily summer maximum temperatures range from 55 to 85 degrees Fahrenheit (°F) and winter maximum temperatures range from 20 to 45° F. Extremely warm or cold weather is usually of short duration. Based on precipitation averages collected between 1953 and 1976, the mean annual precipitation at the plant is approximately 15 inches. Approximately 40 percent of the precipitation falls during the spring, predominantly as wet snow. Autumn and winter are drier seasons, accounting for 19 and 11 percent of the annual precipitation, respectively. Thunderstorms from June to August account for about 30 percent of the total precipitation. Snowfall, generally occurring between October and May, averages 85 inches per year.

1.3.4 Surrounding Land Use and Population Density

The Rocky Flats Plant is located in a rural area. Approximately 50 percent of the area within 10 miles of the Rocky Flats Plant is in Jefferson County. The remainder is located in Boulder County (40 percent) and Adams County (10 percent). According to the 1973 Colorado Land Use Map, 75 percent of this land in 1973 was used for agriculture or was undeveloped. Since 1973, portions of this land have been converted to residential use, with several new housing subdivisions being constructed within a few miles of the buffer zone. One subdivision is located south of Jefferson County Airport, to the northeast, and several are located southeast of the plant (EG&G 1991a).

A recent demographic study shows that approximately 2.2 million people lived within 50 miles of the Rocky Flats Plant in 1989 (U.S. DOE 1990a). Approximately 9,100 people lived within 5 miles of the Plant in 1989. The most populous sector lies to the southeast, toward Denver. Recent population estimates, registered by the Denver Regional Council of Governments (DRCOG) for the eight-county Denver metro region, have shown distinct patterns of growth during the first and second halves of the 1980s. Between 1980 and 1985, the population of the eight-county region increased by 197,890; a 2.4 percent annual growth rate. Between 1985 and 1989, a population gain of 71,575 was recorded, representing a 1.0 percent annual increase (the national average). The 1989 population showed an increase of 2,225 (or 0.1 percent) over 1988 (DRCOG 1989).

There are 8 public schools within 6 miles of the Rocky Flats Plant. The nearest educational facility is Witt Elementary School, approximately 2.7 miles east of the plant buffer zone. The closest hospital is Centennial Peaks Hospital, located approximately 7 miles to the northeast.

The closest park and recreational area is Standley Lake Reservoir, approximately 5 miles southeast of the plant. Boating, picnicking, and limited overnight camping are permitted. Several other small parks exist in communities within 10 miles. The closest major park, Golden Gate Canyon State Park, located approximately 15 miles to the southwest, provides 8,400 acres of general camping and outdoor recreation. Other national and state parks are located in the mountains west of the Rocky Flats Plant, but all are more than 15 miles away.

Some of the land adjacent to the Plant's buffer zone is zoned for industrial development. Industrial facilities within 5 miles include the TOSCO laboratory (a 40-acre site located 2 miles south), the Great Western Inorganics Plant (2 miles south), the Frontier Forest Products yard (2 miles north), the Idealite Lightweight Aggregate Plant (2.4 miles northwest), and the Jefferson County Airport and Industrial Park (a 990-acre site located 4.8 miles northeast). Several ranches are located within 10 miles of the Plant, primarily in Jefferson and Boulder counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1987 Colorado Agricultural Statistics, 20,758 acres of crops were planted in Jefferson County (total land area of approximately 475,000 acres) and 68,760 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of 5,314 head of cattle, 113 hogs, and 346 sheep in Jefferson County, and 19,578 head of cattle, 2,216 hogs, and 12,133 sheep in Boulder County (Post 1989).

1.3.5 Ecology

A variety of plant life is found within the Plant boundary. Species are representative of lower mountainous and foothill ravine regions and include species of tall and short grass prairie. Riparian vegetation exists along the site's drainages and wetlands. None of the vegetative species present on the Rocky Flats facility have been reported to be on the endangered species list (EG&G 1991a). Previously disturbed areas of the plant have revegetated since establishment of Rocky Flats Plant, as evidenced by the presence of disturbance-sensitive grasses like big bluestem (*Andropogon gerardii*) and sideoats grama (*Bouteloua curtipendula).*

The fauna inhabiting the Rocky Flats Plant and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer (*Odocoileus hemionus*), with an estimated 100 to 125 permanent residents. There are a number of small carnivores, such as coyote (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*). A profusion of small herbivores can be found throughout the Plant and buffer zone, consisting of species such as the pocket gopher (*Thomomys talpoides*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow mole (*Microtus pennsylvanicus*) (U.S. DOE 1980).

Commonly observed birds include western meadowlarks (*Sturnella neglecta*), horned larks (*Eremophila alpestris*), mourning doves (*Zenaidura macroura*), and vesper sparrows (*Pooecetes gramineus*). A variety of ducks (*Anas sp.*), killdeer (*Charadrius vociferus*), and red-winged blackbirds (*Agelaius phoeniceus*) are seen near pond areas. Mallards (*Anas platyrhynochos*) and other ducks frequently nest and rear young on several of the ponds. Common birds of prey in the area include marsh hawks (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), and great horned owls (*Bubo virginianus*) (U.S. DOE 1980).

Bull snakes (*Pituophis melanoleucus*) and rattlesnakes (*Crotalus sp.*) are the most frequently observed reptiles. Eastern yellow-bellied racers (*Coluber constrictor flaviventris*) have also been seen. The eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) has been reported on the site, but these and other lizards are not commonly observed. The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds (U.S. DOE 1980).

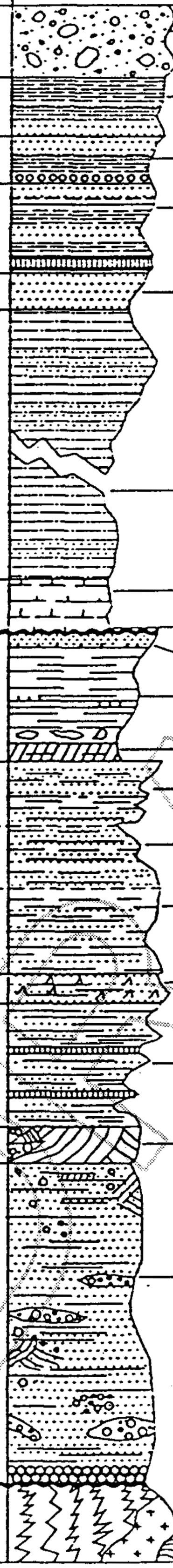
1.3.6 Regional and Local Hydrogeology

The Rocky Flats Plant is located on a broad, eastward-sloping plain of overlapping alluvial fans along the Front Range of the Rocky Mountains. Figure 1-3 presents a generalized stratigraphic section of the Denver Basin bedrock, and Figure 1-4 shows a local stratigraphic section of the Rocky Flats Plant, including unconsolidated deposits. The surficial geology of the OU5 area is presented in Figure 1-5 (EG&G 1990c). Groundwater occurs under unconfined conditions in both the surficial units and the shallow bedrock units. In addition, groundwater occurs in deeper bedrock sandstones under confined conditions. A description of each of the geologic units is discussed in the following subsections.

1.3.6.1 <u>Rocky Flats Alluvium</u>

The Rocky Flats Alluvium is the oldest and topographically highest alluvial deposit in the Rocky Flats Plant area (Figure 1-6). The Rocky Flats Alluvium was deposited by braided streams that produced a series of coalescing alluvial fans. The alluvium is a broad deposit consisting of a topsoil layer underlain by up to 100 feet of varying amounts of silt, clay, and gravel. Unconfined groundwater flow occurs in the Rocky Flats Alluvium, which is relatively permeable. Recharge to the alluvium is from precipitation, snowmelt, and water losses from ditches, streams, and ponds that are cut into the alluvium. General water movement in the Rocky Flats Alluvium is from west to east and toward the drainages. Groundwater flow is also controlled by pediment drainages in the top of the bedrock. Groundwater levels in the Rocky Flats Alluvium rise in response to recharge in the spring and decline in the summer, fall, and winter. Fluctuations in the groundwater level vary approximately 2 to 25 feet within the Plant site vicinity (Hurr 1976). Discharge from the alluvium occurs at seeps in the colluvium that covers the contact between alluvium and underlying bedrock along the edges of the valleys. Most seeps flow

AGE	FORMATION	Thickness (ft)	SUMMARY DESCRIPTION
TERTIARY	Green Mountain	600'	Boulder conglomerate with occasional thin siltstone lenses
TERTIARY	Denver	870'	Yellowish-brown to grayish-olive fluvial tuffaceous claystone, siltstone, and sandstone interbedded with conglomerate and olive-gray mudflows
UPPER CRETACEOUS	Arapahoe	250'	Yellowish-gray to yellowish-brown sandstone; siltstone; and claystone; discontinuous conglomerate at base
UPPER CRETACEOUS	Laramie	700'	Gray, fine-to-medium-grained sandstone and silty clays; thin coal beds in lower part
UPPER CRETACEOUS	Fox Hills	75'	Tan, fine-to-medium-grained sandstone and sandy shale
UPPER CRETACEOUS	Pierre	± 8000'	Dark gray, silty shale and few thin, silty sandstones
UPPER CRETACEOUS	Niobrara	350'	Dark gray, very calcareous shale. "Foraminifers" abundant (Smoky Hills Member) Light gray, dense, fossiliferous limestone (Fort Hays Member)
UPPER CRETACEOUS	Benton	420'	Brown, sandy, fossiliferous limestone Dark gray shale with bentonite streaks; thin limestones in middle part; few cone-in-cone concretions in lower part Dark gray, brittle silty shale (Mowry)
LOWER CRETACEOUS	Dakota Group: So. Platte	270'	Light gray, fine-to-medium-grained sandstone, several dark gray shales in middle part
LOWER CRETACEOUS	Dakota Group: Lytle	100'	Light gray, fine-to-coarse-grained, locally conglomeratic sandstone; frequent red and green siltstone interbeds
Jurassic	Morrison	365'	Gray to greenish-gray to red shale and siltstone; thin limestones in middle part; lenticular sandstones in upper and lower part
Jurassic	Ralston Creek	110	Light tan siltstone and light red; silty shale; gypsiferous; sandstone at base and locally conglomeratic
TRI-ASSIC?	Lykins	400'	Red siltstone with two laminated limestones in lower part
PERMIAN	Lyons	120	Grayish-white, fine-to-medium-grained cross-bedded sandstone; conglomeratic lenses frequent
PENNSYLVANIAN	Fountain	1000'	Red, fine-to-coarse-grained sandstone and conglomerate; arkosic; thin, lenticular red siltstones frequent throughout
PRECAMBRIAN			Gneiss, schist, and small granite intrusions



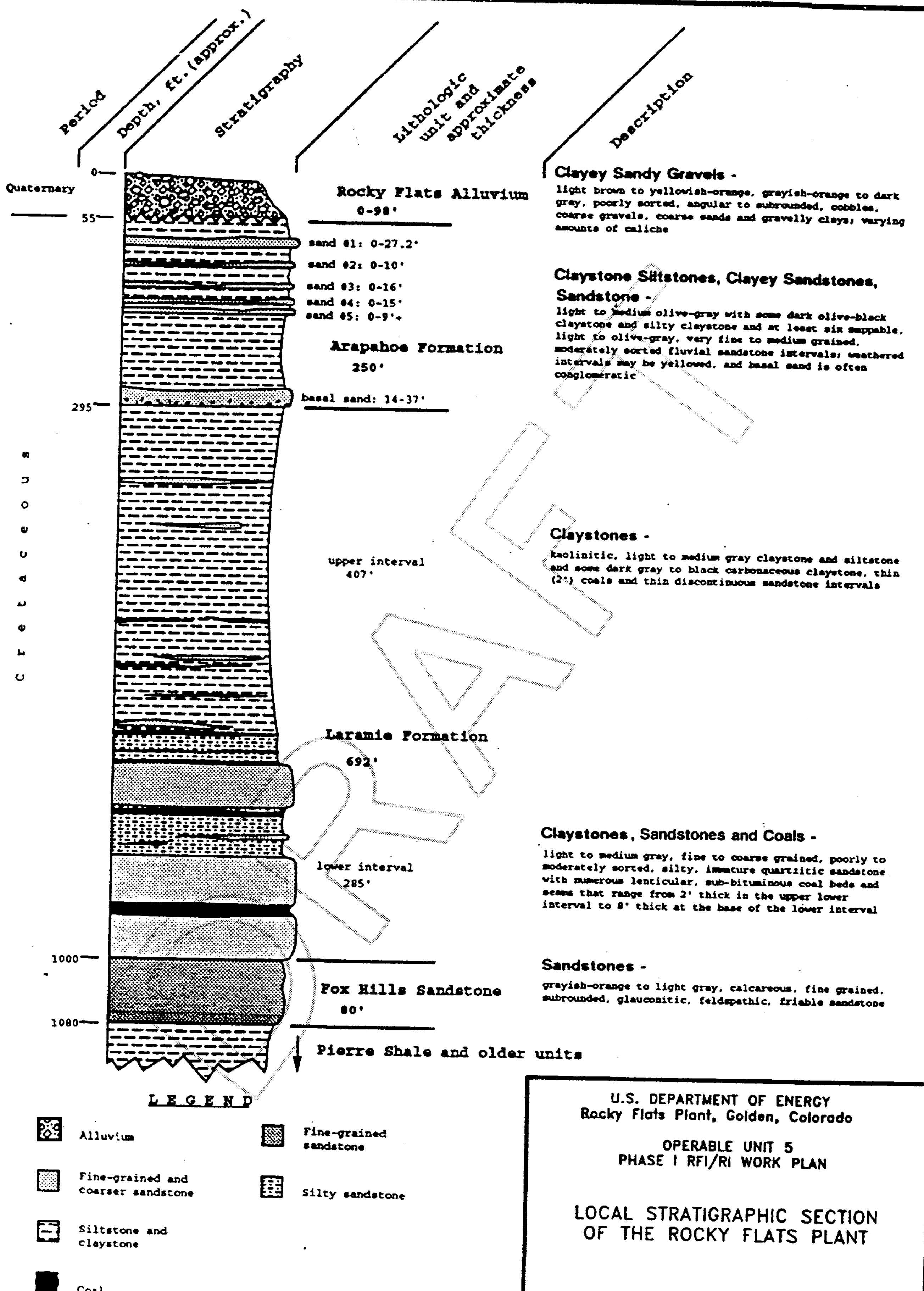
(modified from: Weimer, 1973)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

GENERALIZED STRATIGRAPHIC SECTION OF THE DENVER BASIN BEDROCK

FIGURE 1-3 MARCH 1991



EG&G, 1991

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OPERABLE UNIT 5
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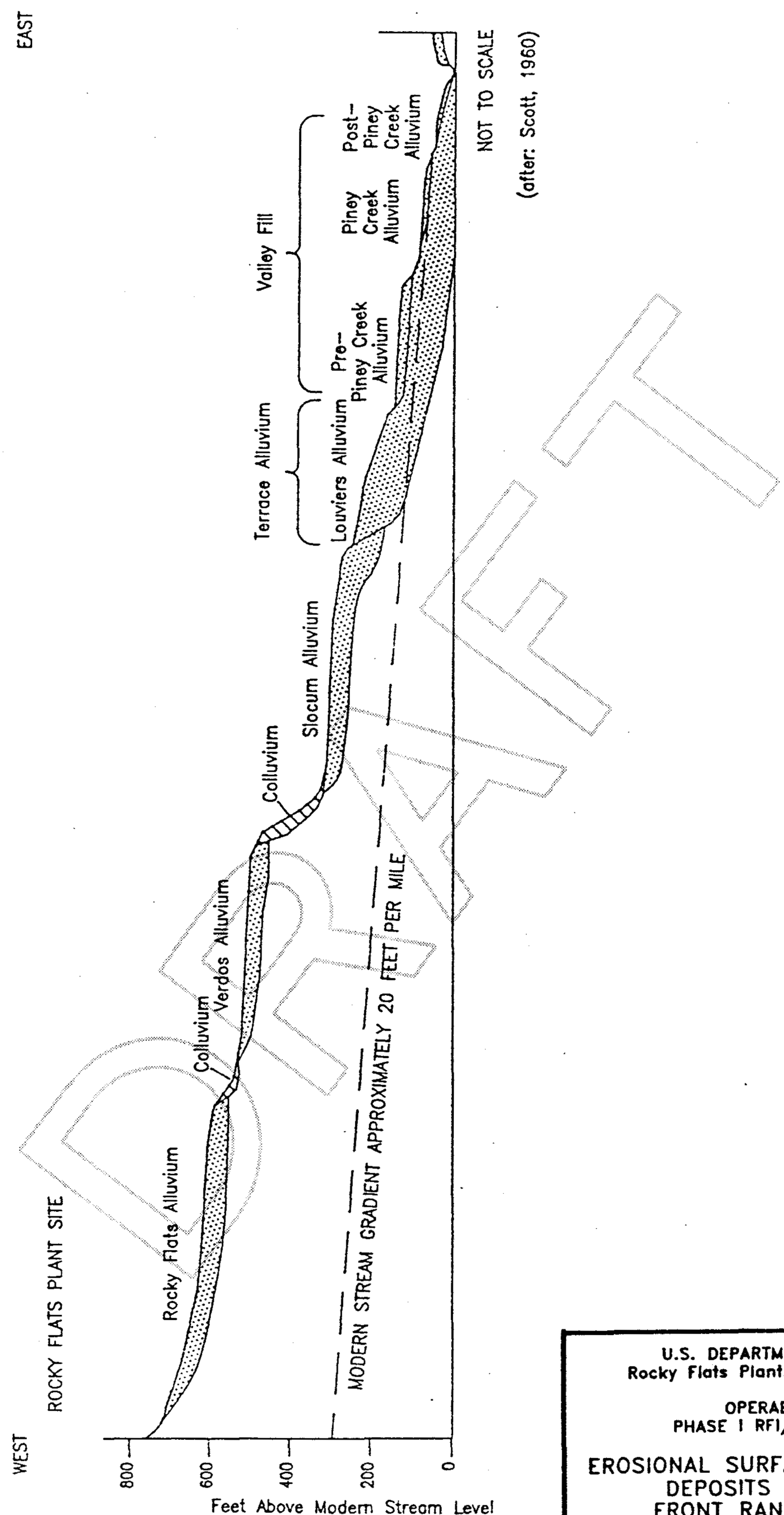
LOCAL STRATIGRAPHIC SECTION OF THE ROCKY FLATS PLANT

FIGURE 1-4

MARCH 1991



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OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

EROSIONAL SURFACES AND ALLUVIAL DEPOSITS EAST OF THE FRONT RANGE, COLORADO

FIGURE 1–6 MARCH 1991

intermittently. The Rocky Flats Alluvium thins and discontinues east of the Plant boundary and, therefore, does not directly supply water to wells located downgradient of the Rocky Flats Plant.

1.3.6.2 Other Alluvial and Colluvial Deposits

Various other alluvial deposits occur topographically below and east of the Rocky Flats Alluvium in the drainages of the Rocky Flats Plant. Colluvium (slope wash) mantles the valley side slopes between the Rocky Flats Alluvium and the valley bottoms. The colluvium is a product of mass wasting that collects on the sides and at the base of hills and slopes. These deposits tend to be poorly sorted mixtures of soil debris from bedrock clay and sand, mixed with gravel and cobbles derived from the older alluvium which caps the hills and ridges (Hurr 1976). The colluvium varies from a few inches to several feet in thickness and rests on bedrock and other alluvial material. In addition to the colluvium, remnants of younger terrace deposits including the Verdos, Slocum, and Louviers alluvial deposits occur occasionally along the valley side slopes. Recent valley fill alluvium occurs in the active stream channels.

Unconfined groundwater flow occurs in these surficial deposits. Recharge occurs through precipitation, infiltration from streams during periods of surface water runoff, and by seeps discharging from the Rocky Flats Alluvium. Discharge occurs through evapotranspiration and by seepage into other geologic formations, subcrops, and streams. The direction of groundwater flow is generally to the east and downslope through colluvial materials, and then along the course of the stream in valley fill materials. During periods of high surface water flow, some of the water is lost to bank storage in the valley fill alluvium and then returns to the stream after the runoff subsides.

1.3.6.3 Arapahoe Formation

Underlying most of the surficial units at the Rocky Flats Plant is the Cretaceous Arapahoe Formation. The Arapahoe Formation is a fluvial deposit consisting primarily of siltstones and claystones, with some silty sandstones beneath the plant. Geologic characterization of the Arapahoe Formation beneath Rocky Flats indicates sandstones occur in stream channel-shaped structures. Formation thickness varies but maximum thickness is approximately 270 feet (Robson et al. 1981a), and the unit is nearly horizontal beneath the plant (less than 2° dip) (EG&G 1990g and 1990e). Predominantly claystones, which were deposited as overbank deposits, comprise the Arapahoe Formation. The sandstone in the upper Arapahoe Formation was deposited by a complex system of meandering streams flowing generally west to east off the Front Range. The lower Arapahoe sandstones were deposited by braided stream systems. These occasional lenticular sandstone units in the Arapahoe Formation are composed predominately of fine-grained sands and silts, and their hydraulic conductivity is equivalent to or less than that of the overlying Rocky Flats Alluvium. The Arapahoe Formation described by earlier RFI/RI studies contains more clay and silt than typically described for other areas within the Denver Basin.

There is a similarity of the siltstones and claystones beneath Rocky Flats of those of the Laramie Formation.

The Arapahoe Formation is recharged by groundwater from overlying surficial deposits and infiltration from streams. The main recharge areas are under the Rocky Flats Alluvium although limited recharge from the colluvium and valley fill alluvium likely occurs along the stream valleys (U.S. DOE 1990a). Recharge is greatest during the spring and early summer, when rainfall and stream flow are at a maximum and water levels in the Rocky Flats Alluvium are high. Groundwater movement on a regional basis is from west to east, in the Arapahoe Formation, although the groundwater flow regime in the bedrock has generally not yet been characterized. Regionally, groundwater flow in the Arapahoe Formation is toward the South Platte River in the center of the Denver Basin (Robson et al. 1981a).

1.3.6.4 Laramie Formation and Fox Hills Sandstone

The Laramie Formation underlies the Arapahoe Formation and is a continental deposit composed of a thick upper claystone unit and lower sandstone unit and coal interval. The claystone is greater than 700 feet thick and is of very low hydraulic conductivity; therefore, the U.S. Geological Survey (Hurr 1976) concluded that Plant operations will not impact any units below the upper claystone unit of the Laramie Formation.

The lower sandstone unit of the Laramie Formation, which is approximately 90 feet thick, and the underlying Fox Hills Sandstone form a regionally important aquifer in the Denver Basin known as the Laramie-Fox Hills Aquifer. Near the center of the basin, the aquifer thickness ranges from 200 to 300 feet. West of the plant, the Laramie-Fox Hills Aquifer can be seen in clay pits excavated through the Rocky Flats Alluvium. The steeply dipping beds of these units west of the plant (approximately a 50° dip) quickly flatten to the east (less than 2° dip) (EG&G 1990g and 1990e). Recharge to this aquifer occurs along the rather limited outcrop area exposed to surface water flow and infiltration along the Front Range (Robson et al. 1981b).

2.0
PRELIMINARY SITE CHARACTERIZATION

Ten Individual Hazardous Substance Sites (IHSSs), geographically located along or within the drainage areas of Woman Creek (Figure 2-1), have been designated as Operable Unit 5 (OU5). These IHSSs are identified in the Environmental Restoration Interagency Agreement (IAG), dated January 22, 1991, as the Original Landfill (IHSS 115), Ash Pits, Incinerator area, and Concrete Wash Pad (IHSSs 133.1 through 133.6), Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), and a Surface Disturbance (IHSS 209). Ponds C-1 and C-2 are the only IHSSs located on Woman Creek. The remaining eight IHSSs are located along the banks and/or upland areas that drain into Woman Creek or into the South Interceptor Ditch (SID). In addition to these ten IHSSs, a surface disturbance south of the Ash Pits (IHSS 133) will also be investigated in the Phase I OU5 investigation.

The initial step in the development of the OU5 work plan was a review of existing information. Available historical and background data for each IHSS were collected through a literature search, which included references at the Rocky Flats Public Reading Room and various libraries within the Rocky Flats Plant, and a review of the RFEDS. Information concerning existing alluvial and bedrock groundwater monitoring wells within the Woman Creek drainage have been collected for this work plan (Table 2-1). Personal communications with plant personnel were also used as a source of information during the background data review so that each IHSS could be better described.

The ten IHSSs are discussed in detail in the following subsections. The location and description of each IHSS, the history of use, surface drainage, nature of contamination, previous investigations conducted at or near the individual IHSSs, geology, and hydrology are discussed. The Ash Pits, Incinerator, and Concrete Wash Pad are grouped together in the following discussions, as are Ponds C-1 and C-2, since these units have interrelated and similar histories. The areal extent and boundary of each IHSS is based on a preliminary review of historical aerial photographs (U.S. EPA 1988b) and the historical operations of the unit. The boundaries for each IHSS in this work plan are the same as those established in the IAG except for the Original Landfill (IHSS 115) and the Surface Disturbance (IHSS 209). The southern boundary of the Original Landfill has been extended approximately 150 feet toward the south across the SID based on a site reconnaissance. The Surface Disturbance boundary was extended to the north and southwest based on a site reconnaissance and aerial photographs. Where previous investigations have been conducted at or near a unit, some of the analytical data are included for reference in the following sections. The inclusion of these data is for informational purposes only. No conclusions are made in this work plan regarding the presence or absence of contamination based on these data. The geology of each IHSS is based on the lithology of nearby wells, personal communications with EG&G personnel, and the Draft Geologic Characterization Report prepared by EG&G (EG&G 1990g). In addition to the review of each IHSS, a conceptual model for each IHSS or similar IHSSs was then developed based

TABLE 2-1

ALLUVIAL AND BEDROCK GROUNDWATER WELLS IN THE VICINITY OF OPERABLE UNIT NO. 5

Well Number	Status	Ground Surface Elevation	Total Depth (feet)	Formation Completed In	Depth to Bedrock	Depth to Bottom of Screen
B402689	1	6045.40	5.85	Qvf	2.80	2.55-3.28
1474	2	5993.30	5.74	--		
5686	1	5977.16	9.60	--	7.0	2.60-9.60
5786	1	5950.77	6.75	Qvf	6.0	2.50-6.50
7086	1	5929.79	7.90	Qvf	7.0	2.36-7.90
0481	2	5944.30	5.41	--		
P416889	3,4	6017.4	21.52	Qrf	20.20	15.86-20.27
P416789	3,4	6027.80	28.20	Qrf	26.40	22.48-26.90
P416589	3,4	6041.20	32.10	Qrf	30.50	27.04-31.0
P416489	3,4	6048.50	26.98	Qrf	25.20	21.27-25.70
P416389	4	6055.40	31.40	Qrf	29.80	25.69-30.10
B405289	1	5965.60	48.0	Kss(u)	10.30	41.24-45.67
B405189	1	5967.90	24.45	Kcl	8.20	13.20-22.69
B405889	1	6024.90	46.75	Kss(w)	6.50	36.04-45.50
B402189	1,3	6024.60	24.60	Kss(w)	7.50	13.5-22.90
B405989	1	6023.50	8.50	Qc	6.20	2.80-6.70
B401989	1,3	6025.60	22.65	Qc	20.50	6.55-21.00
B302089	1,3	5907.50	15.0	Qc	13.50	3.85-13.30
5886	1	5888.89	3.50	Qvf	3.0	1.50-3.50
4886	1	6096.68	207.07	Kss(w)	70.0	191.99-207.07
B301889	1,3	5866.80	24.45	Qc	22.30	13.16-22.60
B304789	1	5867.50	39.14	Kcl	22.90	27.90-37.57
6486	1	5834.48	9.0	Qvf	8.80	3.41-9.0
6586	1	5782.75	8.0	Qvf	7.10	2.50-8.0
1674	1	5767.50	5.41	--		
3087BR	1	5811.87	16.0	Kss(u)	16.0	85.79-94.35

TABLE 2-1
(Continued)

ALLUVIAL AND BEDROCK GROUNDWATER WELLS IN THE VICINITY OF OPERABLE UNIT NO. 5

Well Number	Status	Ground Surface Elevation	Total Depth (feet)	Formation Completed In	Depth to Bedrock	Depth to Bottom of Screen
2987	1	5812.42	20.50	Qc	19.80	3.50-20.30
1487BR	1	5855.0	24.30	Kss(w)	5.20	19.0-24.05
6386	1	5900.40	15.50	Qc	14.80	3.80-15.25
6286	1	5897.54	35.19	Kss(w)	22.0	25.22-35.19
4787	1	5882.72	7.50	Qc	7.0	3.50-7.25
4887	1	5909.94	10.30	Qc	9.80	3.50-10.05
0487	1	5909.79	19.70	Qc	19.50	3.51-19.47
0287	1	5930.56	9.32	Qc	8.75	3.22-9.08
6986	1	5921.19	14.0	Qc	13.30	3.0-14.0
0887BR	1	5919.70	89.34	Kss(u)	8.70	84.0-89.02
5986BR	1	5919.90	28.60	Qc	29.50	20.10-27.30
5986	2	5914.32	28.0	Kss(w)	7.50	19.0-28.0
0387BR	1	5930.58	108.0	Kss(u)	20.0	102.80-107.75

Source (EG&G 1990d)

NOTES:

Key to Well Number:
- Prefix P - 1989 well within plant security area
- Prefix B - 1989 well in the Buffer Zone
- Suffix BR - Bedrock well prior to 1989

Key to Status:
- 1 - Active
- 2 - Inactive
- 3 - Borehole Sampled
- 4 - Observation Well

Key to Geologic Strata:
- Qvf - Valley fill alluvium
- Qrf - Rocky flats alluvium
- Qc - Colluvium
- Kcl - Bedrock Claystone
- Kss(u) - Bedrock unweathered sandstone
- Kss(w) - Bedrock weathered sandstone

on the existing data for each. These models identify and describe contaminant sources, potential migration and exposure pathways, and receptors.

Also discussed in the following section is the Woman Creek drainage system adjacent to the plant site. Woman Creek is the drainage system that provides a common physical setting for all the IHSSs in OU5.

2.1 WOMAN CREEK

The Rocky Flats Plant is geographically located on a plateau and is bounded on the south by the Woman Creek drainage (Figure 2-1). Woman Creek flows from west to east through the Rocky Flats facility and into Standley Lake Reservoir and Mower Reservoir about 1 ½ miles from the facility's eastern boundary (Figure 1-2). Woman Creek originates near Coal Creek approximately 1 ½ miles to the west of Highway 93. Near the west boundary of the plant facility, within the buffer zones, Woman Creek crosses under the South Boulder diversion canal. The canal cross over is constructed of wood and presently contributes water to Woman Creek due to leakage. Other waters which enter into Woman Creek within the buffer zone include upstream runoff and water released from the Rocky Flats Lake. Water is released from Rocky Flats Lakes into Woman Creek by a local rancher as part of his water rights agreement. This flow is diverted out of Woman Creek to Mower Reservoir below Pond C-2.

The natural drainage of Woman Creek has been somewhat modified in the OU5 area by the construction of Ponds C-1 (IHSS 142.10) and C-2 (IHSS 142.11) and the SID south of the plant site. Currently, Woman Creek flows eastward through OU5 in its natural stream channel to Detention Pond C-1 (IHSS 142.10) (Figure 2-1). The purpose of Detention Pond C-1 is for stormwater management and for sampling and monitoring of the water upstream in Woman Creek. Water is rarely retained within this pond as the outlet or gate is usually open and the water is allowed to flow through the pond. The water consequently flows in its natural channel until just west of Pond C-2 where it is diverted around Pond C-2 by a diversion canal. Downgradient and to the east of Pond C-2, approximately two thirds of the water is diverted from Woman Creek's main channel into an unnamed ditch to Mower Reservoir. The remaining flow continues to flow downstream in Woman Creek and into Standley Lake Reservoir.

In 1980, the SID was constructed upslope (to the north) of Woman Creek (Figure 2-1). The SID was built to intercept surface runoff from the plant site. A berm was constructed on the downslope side of the SID to contain the water flowing in this ditch. Since construction of the SID in 1980, Woman Creek has not received runoff directly from the southern part of the plant facility. Surface water flow in the SID is intermittent and usually occurs only following precipitation events or snow melt. When flow is low, water tends to pond in several areas of the ditch. The SID begins approximately 200 feet east of the Ash Pits and runs for almost 2 miles to Detention Pond C-2 (IHSS 412.11) (Figure 2-1). Just upslope of Pond C-2, the water flowing in the SID crosses over Woman Creek and flows into Detention Pond

C-2. As-built drawings for Pond C-2 are presented in Appendix A of this work plan. In Pond C-2, the water is sampled and analyzed monthly and discharged according to a National Pollutant Discharge Elimination System (NPDES) permit (Permit Number CO-0001333). The water discharged from Pond C-2 is pumped via pipeline to the Broomfield Diversion Ditch, which carries the water around Great Western Reservoir into Big Dry Creek. Prior to construction of this pipeline in August 1989, surface water from Pond C-2 was discharged to Woman Creek.

The Woman Creek drainage is included in the Plant-wide Radioactive Ambient Air Monitoring Program (EG&G 1991b). Monitoring stations for this program are shown on Figure 2-1.

2.2 ORIGINAL LANDFILL (IHSS 115)

2.2.1 Location and Description

The Original Landfill is located within the buffer zone just south of the Rocky Flats Plant security area and south of the west access road (Figure 2-2). It is located 250 feet north of Woman Creek on a moderately to steeply sloping south-facing hillside. The boundary of the landfill has been determined principally from historic aerial photographs and from the operational history of this unit. The landfill is approximately 240,000 square feet (5.5 acres) (Figure 2-2). The southern boundary of this IHSS has been extended farther south for the purpose of this work plan since it is now believed that wastes may be south of the SID. Elevations of this IHSS range from about 5,980 feet to 6,040 feet.

2.2.2 History

The Original Landfill was in operation from 1952 to 1968 and was used to dispose of general wastes generated at the Rocky Flats Plant. It is estimated that 2 million cubic feet of miscellaneous Plant wastes are buried in the landfill, including such things as solvents, paints, paint thinners, oil, pesticides, and cleaners (Rockwell 1988). These wastes were not considered hazardous prior to 1968, when they were placed in the landfill. The landfill also received beryllium and/or uranium wastes and may originally have been used as a graphite dump. It is reported that ash containing an estimated 20 kilograms (kg) of depleted uranium (U.S. DOE 1986b), produced when 60 kg of depleted uranium were inadvertently burned, was buried within the landfill. Small quantities of various other chemicals are also believed to be buried within the landfill (Rockwell 1988). In a previous report, several sealed drums were reported to have been present on the north side of the landfill based on an interpretation of a 1969 aerial photograph (Rockwell 1988). In 1978, the surface over the entire landfill appeared very hummocky. A letter, dated August 23, 1979, from Rockwell International to DOE, stated that hot spots containing depleted uranium were uncovered in the landfill. All hot spots were removed from the landfill in one box of soil during July 1979 (Rockwell 1979). By 1980 the SID had been built across the southern tip of the landfill.

An evaporation/settling pond, that was used for backflushing sand filters from the water treatment facility (Building 124), was located approximately 25 feet southwest of the present surface water location SW-37(Rockwell 1988) (Figure 2-2). This pond was visible in a 1955 aerial photograph, but by 1964 this pond was no longer present and the area had been covered by fill. Several other activities at the landfill are apparent from aerial photographs of the area (U.S. EPA 1988b). A surface disturbance area east of the landfill was active in the 1964 aerial photograph (Figure 2-2). Little documented historical information is available concerning this area; however, this area may have served as a storage yard for pipes and scrap metal. In addition, soil appears to have been placed in this area as substantial mounds of debris are noted in this area in the 1969 and 1971 aerial photographs (U.S. EPA 1988b).

The landfill was closed with a soil cover; however, a bottom liner was not installed. Details of the construction of the surface cover are not available, nor is the year the cover was installed. A few years ago, the slope on the south side of the landfill was regraded to correct sloughing and erosion-related problems. The surface of the landfill is currently hummocky and irregular.

Two 3-foot-diameter corrugated metal pipes protrude from the landfill (Figure 2-2). No flow was observed from these pipes during several site visits in 1990. The west pipe appears to be connected to an abandoned storm drain constructed with 15-inch vitrified clay pipe (Rockwell 1988). The pipe to the east is reported to be connected to a 36-inch reinforced concrete pipe, which is connected to the footing drains of Building 460 and possibly several drainage pipes on the plant site (U.S. DOE 1987). Currently, the surface outfall of this pipe does not appear to be connected to a drainage pipe. In July 1986, after a major rainstorm, seepage began emerging from the Original Landfill (U.S. DOE 1987). This seepage was subsequently traced to the eastern-most pipe. The SID was enlarged shortly after the seepage was recognized. During a site visit in February 1988, water was heard flowing within this eastern pipe (Rockwell 1988). In addition, a berm structure was constructed south of the SID to prevent surface runoff from crossing the SID during a major storm event. A containment embankment was constructed near the eastern-most outfall pipe to stabilize the irregular and hummocky surface that existed at the landfill; however, details of this construction are not available.

2.2.3 Surface Drainage

The upslope area that drains across the Original Landfill (IHSS 115) is small with downslope flow coming principally from south of the west access road (200 feet to the north of the Original Landfill). Surface runoff across IHSS 115, therefore, is minimal, with runoff from this IHSS flowing downslope to the south where it empties into the SID (Figure 2-2). The moderate to steep slope of the landfill typically results in relatively rapid flow of surface water across this unit and limits the amount of ponding that occurs. The SID is located approximately 300 feet upslope of Woman Creek and collects almost all of the surface runoff from the landfill (Figure 2-2). Water in the SID flows eastward to Detention Pond C-2 (IHSS 142.11) approximately 1½ miles to the east (IHSS 142.11, Section 2.4).

2.2.4 Nature of Contamination and Previous Investigations

Chemicals that may have been placed in this landfill include commonly used solvents, such as trichloroethylene, carbon tetrachloride, tetrachloroethylene, petroleum distillates, 1,1,1-trichloroethane, dichloromethane, benzene, paint and paint thinners. Metals such as beryllium, uranium, lead, and chromium may also be present (Rockwell 1988). Accurate records of any further wastes placed in this landfill are not available and no additional site-specific investigations have taken place except for a gamma radiation survey that was recently conducted over the landfill by EG&G. The results of this study are still in progress.

To provide some background data for this area, analytical results from groundwater samples collected in monitoring well 7086 during 1989 were reviewed. This well is located downslope of the landfill and just north of Woman Creek (Figure 2-2). The maximum concentration detected for most analytes has been tabulated and can be found in Table 2-2. These data were obtained from the RFEDS. Most of the analytical data have not yet been validated; consequently, there are uncertainties in the unvalidated data. Volatile organic compounds (VOCs) have been detected by a Photoionization detector (PID) in the head space of wells 7086 and 5786 immediately after removal of the protective well cap. Organic concentrations measured by the PID ranged between 10 and 20 ppm (Rockwell 1988).

2.2.5 Geology and Hydrology

The geology near the Original Landfill has been characterized from the information obtained from nearby monitoring wells and by the general knowledge of the geologic setting of the Rocky Flats site. Six groundwater monitoring wells (0481, 7086, 5786, B416689, P416589, and P416489) have been installed near the Original Landfill (Figure 2-2). However, there are no wells within IHSS 115, so specific data on the geology and hydrogeology beneath the landfill are lacking.

A north-to-south cross section through the Original Landfill area is shown in Figure 2-3. The three geologic units that are present beneath the Original Landfill are colluvium, Rocky Flats Alluvium, and the Arapahoe Formation. The nature and thickness of these formations beneath the landfill area are unknown as the nearby monitoring wells are located on the plateau above the Original Landfill or along the Woman Creek drainage. The erosion and depositional processes in these two areas are different from the sloping area where the Original Landfill is located. Therefore, the thickness and depth of these formations beneath the landfill can only be estimated. In the following subsections each of the three formations present (colluvium, Rocky Flats Alluvium, and Arapahoe Formation) and the hydrogeology near the landfill are discussed.

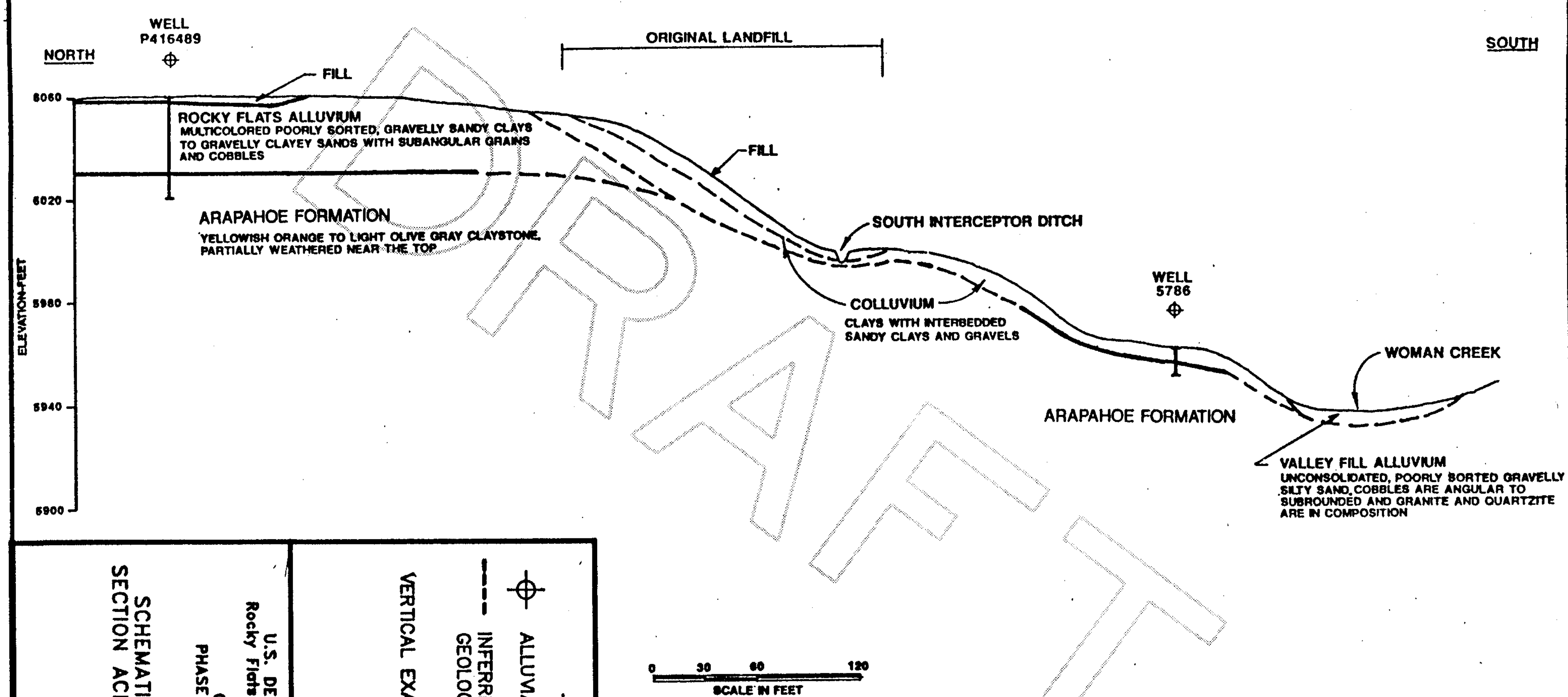
TABLE 2-2

MAXIMUM CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED FROM WELL 7086 IN 1989

Analyte			
Radionuclides	Concentration[3] (pCi/l)		
Americium-241	0.003	±	0.004
Gross Alpha	8.2	±	2.8
Gross Alpha (Filtered)	1.6	±	0.7
Gross Beta	6.7	±	3.1
Gross Beta (Filtered)	17.2	±	3.2
Tritium	270.0		
Strontium-90	0.3	±	0.3
Uranium-235	0.04	±	0.07
Uranium-238	0.03	±	0.06
Metals	Concentration[3] (mg/l)		
Iron	0.475[1]		
Magnesium	9.9831		
Manganese	0.2922		
Strontium	0.4662		
Sulfate	54.3[1]		
Selenium	0.0166		
Zinc	0.0401		
Mercury	0.0003[2]		
Barium	0.0785[1]		
Sodium	31.9257		
Calcium	43.80[1]		
Organics	Concentration[3] (μg/l)		
Trichloroethylene	3.0		
Anions and Cations	Concentration[3] (mg/l)		
Chloride	16.7		
Potassium	3.520[1]		
Sulfate	54.3[1]		
Carbonate, Hydrogen	186.0		
Indicator	Concentration[3] (mg/l)		
Total Dissolved Solids	285.0		

Note: [1]Concentration validated
[2]Concentration is acceptable with qualifications
[3]Potential applicable or relevant and appropriate requirements for OU5 are presented in Section 3.0.

Source: (EG&G 1990d)



EXPLANATION

ALLUVIAL MONITORING WELL

INFERRED BOUNDARY OF GEOLOGIC UNITS

VERTICAL EXAGGERATION 1.5X

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SCHEMATIC GEOLOGICAL CROSS SECTION ACROSS ORIGINAL LANDFILL

FIGURE 2-3

MARCH 1991

Colluvium

Colluvial deposits are thought to exist beneath the Original Landfill based on their presence on similar sloping areas of the Rocky Flats facility. The colluvium is typically deposited by slope wash and downslope creep of the Rocky Flats Alluvium and/or the Arapahoe Formation. These deposits tend to be poorly sorted mixtures of soil and debris from bedrock clay and sand, mixed with gravel and cobbles of the alluvium. The thickness of colluvium beneath the landfill is unknown but the colluvium and the Rocky Flats Alluvium are likely to be less than 25 feet thick. A combined thickness isopach map of the colluvium and Rocky Flats Alluvium is shown in Figure 2-4.

Rocky Flats Alluvium

The Rocky Flats Alluvium consists of multicolored poorly sorted gravelly sandy clays to gravelly clayey sands with subangular grains and scattered cobbles. This unit is the oldest and topographically highest alluvial deposit at the Rocky Flats Plant. The Rocky Flats Alluvium unconformably overlies all the older bedrock formations. The Alluvium generally slopes to the east (Hurr 1976).

The thickness of the Rocky Flats Alluvium below the Original Landfill is unknown; however, this unit is likely to be approximately 20 to 25 feet thick based on the thickness of the Rocky Flats Alluvium in monitoring wells P416489 and P416589 north of the landfill.

Arapahoe Formation

The Arapahoe Formation encountered in wells adjacent to the Original Landfill is a fairly uniform yellowish-orange to light olive-gray claystone that is weathered near its top. The depth to this formation in the vicinity of the Original Landfill varies, but generally becomes shallower to the south toward Woman Creek drainage. In nearby wells, the Arapahoe Formation has been encountered from 6 to 30 feet below the ground surface.

Hydrogeology of the Original Landfill

The uppermost aquifer beneath the landfill is likely to be colluvium and possibly Rocky Flats Alluvium. The groundwater level is probably between 10 to 20 feet below the ground surface in this area and under unconfined conditions. Fluctuations in the groundwater level occur on a seasonal basis (Rockwell 1988).

The hydraulic gradient in the colluvium and Rocky Flats Alluvium aquifer beneath the Landfill is to the southeast (Figure 2-5). This groundwater gradient is principally controlled by the erosional surface of the underlying Arapahoe Formation. Generally, in steeply sloping areas of the site, such as the area of the Landfill, the groundwater in the Rocky Flat Alluvium and colluvium flows downslope along the fairly impermeable surface of the underlying Arapahoe Formation until it reaches Woman Creek. At Woman Creek the hydraulic gradient changes to the east and parallels the Woman Creek drainage.

The lithology of the Arapahoe Formation beneath the landfill, if similar to the lithology encountered in upgradient and downgradient wells near the landfill, is a claystone and is fairly impermeable. Groundwater in the overlying alluvium is thus not expected to migrate significantly downward into the Arapahoe Formation. However, within the uppermost section of the Arapahoe Formation, as observed at several locations beneath the Plant Site, subcropping sandstones have been encountered. Further characterization of the lithologic nature of the bedrock beneath this IHSS, is therefore, needed.

2.3 ASH PITS 1-4 (IHSSs 133.1, 133.2, 133.3, 133.4), INCINERATOR (IHSS 133.5), AND CONCRETE WASH PAD (IHSS 133.6)

There are six IHSSs discussed together in the following subsections (four Ash Pits, the Incinerator and the Concrete Wash Pad). These six IHSSs have been grouped together because of their proximity to each other and interrelated histories.

2.3.1 Location and Description

The Incinerator, Ash Pits, and Concrete Wash Pad are located south-southwest of the main security area of the Rocky Flats Plant, south of the west access road and north of Woman Creek (Figure 2-6). The locations of these IHSSs are defined from historic aerial photographs. The Incinerator, which had a 10- to 20-foot stack, was located along the plant's original west boundary, off the west access road. The Ash Pits are located to the east, and Concrete Wash Pad to the southwest of the Incinerator. Ash Pits 1, 2, 3, and 4 (IHSSs 133.1, 133.2, 133.3, and 133.4) are approximately 8 feet wide by 150 feet long and 3 feet deep. However, these Ash Pits may be larger as the exact boundaries and dimensions of each unit are somewhat undefined (U.S. DOE 1987). The four Ash Pits are located on a relatively flat surface and are currently covered by tall grasses (Figure 2-6).

The Incinerator area (IHSS 133.5) occupies approximately 4,000 square feet and the Concrete Wash Pad (IHSS 133.6) covers an area of about 33,000 square feet. These two IHSSs are located west of the four Ash Pits. The Concrete Wash Pad has an extremely irregular hummocky surface that slopes gently to the south toward Woman Creek.

The distance from these IHSSs to Woman Creek varies from about 25 feet to 630 feet with the Concrete Wash Pad being the closest to Woman Creek (Figure 2-6). A steep slope is present just north of the Ash Pits and the incinerator area. A dirt road crosses Ash Pit 3 (IHSS 133.3).

2.3.2 History

The Incinerator (IHSS 133.5) was used to burn general plant wastes between the 1950s and 1968. Depleted uranium is also believed to have been burned in the incinerator (Rockwell 1988). A review of aerial photographs revealed that the Incinerator was removed by 1971 and the entire area was beginning to revegetate (U.S. EPA 1988b). Ashes from the Incinerator were placed into the Ash Pits (IHSSs 133.1 through 133.4) or were pushed over the side of the hill into the Woman Creek drainage and/or onto the Concrete Wash Pad (IHSS 133.6) (Rockwell 1988). Following the shutdown of the Incinerator after 1968, the Ash Pits were covered with fill (Rockwell 1988); however, information about the material used in the construction of the cover is unavailable.

The history of the Concrete Wash Pad has not been as well documented as the Ash Pits or Incinerator area. It appears that this area was used to dispose of waste concrete from the concrete trucks involved in the construction activities of the plant facility. It is also likely that the concrete trucks were washed down in this area after delivering concrete.

2.3.3 Surface Drainage

A steep slope is present north of these six IHSSs and surface runoff from these units is toward the south. The upslope area that contributes runoff to these IHSSs is not very large since drainage north of the access road is intercepted by a ditch along the road. Consequently, only a small amount of runoff crosses these units (Figure 2-6). The soils which cover these IHSSs probably limit contact of surface water with the materials that may be present. The surface runoff from these IHSSs flows into Woman Creek to the south. The SID originates approximately 200 feet east of these IHSSs and therefore does not divert any of the runoff coming from these units. The runoff from these IHSSs, after draining into Woman Creek, flows into Pond C-1 (IHSS 142.10). The water is sampled and analyzed from this pond on a monthly basis; however, the water is usually not detained within the pond but allowed to flow downstream into Woman Creek.

2.3.4 Nature of Contamination and Previous Investigations

The history of the Ash Pits, Incinerator area, and Concrete Wash Pad is not entirely known because few records were kept of their operations. It is, known, however, that general combustible wastes from the Rocky Flats plants facility were burned in the Incinerator along with an estimated 100 grams of depleted uranium (Owen 1973). The ashes from the Incinerator were disposed in the Ash Pits. At the Concrete

Wash Pad Area (IHSS 133.6), potentially contaminated materials consist of concrete debris and occasional ashes from the Incinerator that were reported to have been pushed over the side of the hill onto the Concrete Wash Pad area (Rockwell 1988).

A rayscope survey was conducted over Ash Pit 3 (IHSS 133.3) prior to 1973 and the results of this survey detected metals (type unknown) (U.S. DOE 1987). No documentation exists as to whether the other ash pits (IHSSs 133.1, 133.2, and 133.4) had a rayscope survey done over their surfaces.

Groundwater samples collected from monitoring well 5686 during 1989 provide some groundwater quality data for this area. This well is located between the Ash Pits and Woman Creek (500 feet downgradient of IHSS 133.3) (Figure 2-6). The maximum concentration for the analytes tested have been tabulated in Table 2-3.

2.3.5 Geology and Hydrology

The geology near and beneath the Ash Pits and Incinerator area (IHSSs 133.1 through 133.5) is likely to be similar to the geology that underlies the Original Landfill, located 500 feet to the east and on the same sloping hillside (see Subsection 2.2.5). The geologic units present in this area include the colluvium, Rocky Flats Alluvium, and the Arapahoe Formation. For a detailed lithologic description of each of these rock units, see subsection 2.2.5. The thickness of these geologic units near this area is unknown since the three closest monitoring wells (1474, 5686, and B402689) have been drilled within the Woman Creek drainage itself and thus encountered somewhat different geologic conditions. However, the colluvium and Rocky Flats Alluvium have been estimated to be less than 20 feet in this area based on an isopach map of the colluvium and Rocky Flats Alluvium in the vicinity of the Original Landfill (Figure 2-4).

The geology below the Concrete Wash Pad may be slightly different than the Ash Pits and Incinerator area since this unit is closer to the Woman Creek drainage. The geology within the Woman Creek drainage consists of approximately 2 to 8 feet of valley fill alluvium overlying the Arapahoe Formation. Valley fill alluvium a few feet thick was encountered in well B402689, located approximately 1,000 feet upgradient (west) of the Concrete Wash Pad within the Woman Creek drainage area. The valley fill alluvium in this well is described as an unconsolidated dark brown gravel. The Arapahoe Formation is

TABLE 2-3

MAXIMUM CONCENTRATION DETECTED IN GROUNDWATER SAMPLES COLLECTED IN WELL 5686 IN 1989

Analyte			
Radionuclides	Concentration[3] (pCi/l)		
Cesium	0.17	±	0.48
Gross Alpha	1.0	±	1.0
Gross Beta	4.2	±	2.6
Tritium	270.0		
Plutonium - 239	0.004	±	0.007
Strontium - 90	0.56	±	0.44
Uranium - 235	0.13	±	0.27
Uranium - 238	0.13	±	0.27
Metals	Concentration[3] (mg/l)		
Antimony	0.0577[2]		
Arsenic	0.0256[2]		
Iron	0.669[1]		
Magnesium	7.15[1]		
Manganese	0.0053[1]		
Strontium	0.18[1]		
Aluminum	0.1174		
Copper	0.0058		
Barium	0.0723[1]		
Calcium	30.0[1]		
Sodium	23.2[1]		
Organics	Concentration[3] (µg/l)		
Tetrachloroethylene	5.0[1]		
Anions and Cations	Concentration[3] (mg/l)		
Carbonate, Hydrogen	99.7		
Chloride	51.4[1]		
Nitrate/Nitrite	0.07[1]		
Potassium	1.35[1]		
Sulfate	20.4[1]		
Indicator	Concentration[3] (mg/l)		
Total Dissolved Solids	200[2]		

Note: [1] Concentration validated
[2] Concentration is acceptable with qualifications
[3] Potential applicable or relevant and appropriate requirements for OU5 are presented in Section 3.0

Source: (EG&G 1990d)

a grayish-orange slightly silty claystone, that is calcareous. Beneath the northern part of the Concrete Wash Pad, colluvium/Rocky Flats Alluvium may exist because this area is close to the sloping hillside where these units are present.

There are no wells immediately adjacent to or on IHSSs 133.1 through 133.6, so specific hydrogeologic data beneath this area is lacking. Based on the lithology of wells in the vicinity, however, it is estimated that the uppermost aquifer underlying these IHSSs is the colluvium/Rocky Flats Alluvium and valley fill alluvium. Groundwater occurs 4 to 8 feet below ground surface (Rockwell 1988). Groundwater flow direction near these IHSSs is probably toward the Woman Creek drainage. Adjacent to Woman Creek, the flow direction changes to the east, similar to the Woman Creek flow direction (Figure 2-5). The Arapahoe Formation which underlies these surficial units has not been characterized in this area. Therefore, the lithology of the Arapahoe Formation would need to be determined to evaluate possible hydraulic communication, if any, between the bedrock and uppermost aquifer.

2.4 PONDS C-1 AND C-2 (IHSSs 142.10 AND 142.11)

2.4.1 Location and Description

Ponds C-1 (IHSS 142.10) and C-2 (IHSS 142.11) are located along Woman Creek, southeast of the main security area of the Rocky Flats Plant and within the Buffer Zone (Figure 2-7). These ponds are approximately 2,000 feet apart, with Pond C-1 to the west of Pond C-2. The estimated capacities for Ponds C-1 and C-2 are approximately 750,000 gallons and 22,480,000 gallons, respectively. The as-built plans for Pond C-2 are in Appendix A (EG&G 1991c). No as-built drawings exist for Pond C-1. A description of how these ponds interact with the Woman Creek surface water flow is contained in Section 2.1.

2.4.2 History

The C-series Detention Ponds are used primarily to capture and control surface water runoff from the plant's facilities and from Woman Creek. Filter backwash water from the water treatment facility was discharged to Pond C-1 (IHSS 142.10) between plant start-up in 1952 and December 21, 1973 (U.S. DOE 1980). In addition, the cooling tower blowdown water was discharged to Pond C-1 until the latter part of 1974. In the early 1970s, the plant operations were changed and Pond C-1 was used principally to manage the surface water runoff in the Woman Creek drainage.

Pond C-2 (IHSS 142.11) was constructed in 1980 to detain runoff water from the SID (see Section 2.1). The water in Pond C-2 is monitored monthly and discharged periodically. The discharged water is treated by an activated carbon treatment facility and pumped via pipeline toward Great Western

Reservoir, where the water is diverted around this Reservoir by the Broomfield Diversion Ditch. The Broomfield Diversion Ditch empties into Big Dry Creek. The discharge from Pond C-2 is regulated by an NPDES permit (Permit Number CO-0001333). The last time Pond C-2 was discharged was in June 1990. Currently, the pond (as of January 1, 1991) is about 25 percent full, containing approximately 5.7 million gallons.

2.4.3 Surface Drainage

The surface drainage system into Detention Ponds C-1 and C-2 has already been discussed in Section 2.1. Detention Pond C-1 receives surface water from Woman Creek with little runoff received from the plant site. Pond C-2 receives the runoff from the southern plant facilities via the SID.

2.4.4 Nature of Contamination and Previous Investigations

Several studies have been conducted pertaining to the analyses of water and sediment samples from Detention Ponds C-1, C-2, and along Woman Creek drainage. Included in these studies was a 1970 study conducted by the EPA (U.S. EPA 1970), a 1980 study by D. Paine on plutonium in freshwater systems at Rocky Flats (Paine 1980), and a 1986 study conducted as a requirement for a RCRA Part B - Operating Application (U.S. DOE 1986c). In addition, analytical results from surface water samples collected in Ponds C-1 and C-2 and at three locations along Woman Creek during 1989 have been summarized as part of this work plan.

The study conducted in February 1970 involved the analyses of radionuclides in a water sample and bottom sediment sample collected in Woman Creek near Indiana Street (U.S. EPA 1970). Bottom sediment samples were collected by scraping the bottom area below the water line with a hand trowel. Grab samples of water were collected in 1-gallon plastic containers with 2 to 5 gallons collected per sample. Radionuclides detected in the water samples included gross alpha (0.9 pCi/l), Sr-89 (0.5 pCi/l), Sr-90 (0.4 pCi/l), total alpha radiation ($<$0.1 pCi/l), and uranium (2.2 μg/l). No analyses were done for tritium. Radionuclides detected in the bottom sediment included gross alpha (9.0 pCi/gram dry weight), total alpha radiation (4.8 pCi/gram dry weight), plutonium-239 (0.23 pCi/grams dry weight), and uranium (1.5 μg/l) (U.S. EPA 1970).

The 1980 study by D. Paine was conducted in order to determine the behavior of plutonium in the freshwater systems at Rocky Flats (Paine 1980). In this study, sediment cores were taken at 5-cm intervals on a monthly basis from Pond C-1 during the study period (spring of 1971 through the summer of 1973). These core samples were taken to determine the vertical distribution of plutonium in the pond sediments. Surface water samples and water samples were collected at 0.5-meter increments from the pond surface to the sediment/water interface.

The average or mean plutonium concentrations (Pu-239 and Pu-240) in unfiltered water and surface sediments taken from Pond C-1 during this study period is illustrated in Figure 2-8. The sediment samples collected at depth showed no significant vertical variation in plutonium concentrations with depth, probably because of the shallow nature of Pond C-1. In addition, the plutonium concentrations detected in the pond sediments of Pond C-1 are relatively low in comparison to Ponds B-1, B-2, B-3, B-4 and A-1. This may be due to the relatively low percentage of plutonium in the filterable fraction of the water samples (Table 2-4). In this 1980 study, Paine concluded that sediments (especially clays) appear to be the major reservoir for ultimate plutonium deposition and that relatively insignificant transport of plutonium through biotic systems to man exist.

The 1986 study "Trends in the Rocky Flats Surface Water Monitoring" summarized analytical data collected between 1980 and 1985 (U.S. DOE 1986a). Maximum plutonium concentrations measured in the surface water of Pond C-2 during this period were 0.05 pCi/l. Maximum concentrations for uranium and americium at the NPDES designated discharge point below Pond C-2 were 2.8 pCi/l and 0.02 pCi/l, respectively. For Pond C-2, the maximum tritium concentrations detected were 1200 pCi/l. Nitrate concentrations remained nearly constant in Pond C-2 throughout the five-year period and the pH in Pond C-2 ranged between 8.0 and 8.5 (Rockwell 1988). Sediment samples were not collected in Ponds C-1 or C-2 for this study.

In addition to the historical studies, surface water samples are currently collected monthly to monitor the water quality of the detention ponds. A surface water monitoring program was established several years ago at Rocky Flats facility and is presently being supervised by EG&G personnel. Numerous established surface sampling locations along the drainage area of Woman Creek and within Ponds C-1 and C-2 are sampled on a monthly basis providing there is water present and the water is not frozen. Analytical results from surface water samples collected during 1989 from Ponds C-1 and C-2 were reviewed for this work plan to provide more recent data on the ponds (Figure 2-7). These surface water samples collected, SW-C1 and SW-C2, from Ponds C-1 and C-2, respectively, are collected at the deepest part of the pond and analyzed for radionuclides, metals, and organics. The maximum concentrations detected during 1989 for most analytes in each of the ponds have been tabulated in Table 2-5. In addition, analytical data from three surface water locations along Woman Creek were also summarized for this work plan and the maximum concentrations detected for radionuclides and metals during 1989 have been tabulated in Table 2-6. These data have not yet been validated; therefore, there are uncertainties in the unvalidated data. Several sediment sampling locations have also recently been established along the Woman Creek drainage; however, limited chemical analytical data are available at this time from samples that have been collected.

Discharges from Pond C-2 are regularly monitored to comply with an NPDES permit. These discharges are also monitored for plutonium, americium, uranium, and tritium (U.S. DOE 1986c). Water quality and flow measurements are monitored during periods of discharge from Pond C-2.

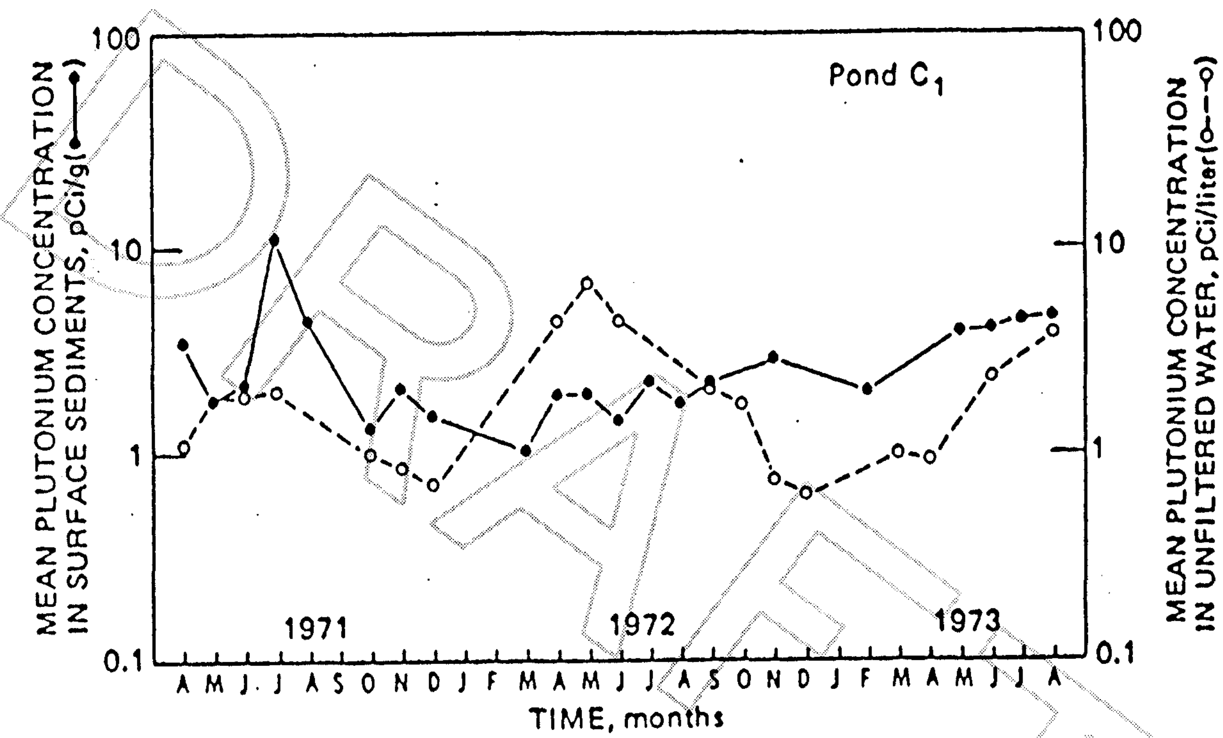


FIGURE 2-8 Mean plutonium concentrations in surface sediments (pCi/g) and mean plutonium concentrations in unfiltered water (pCi/l) for Ponds C-1

Source: Paine 1980

TABLE 2-4

PERCENT OF PLUTONIUM ISOTOPES ASSOCIATED WITH FILTERABLE FRACTION OF WATER SAMPLES FROM ROCKY FLATS PONDS

Pond	Filterable Fraction*
B-1	90 ± 6
B-2	80 ± 12
B-3	80 ± 8
B-4	70 ± 12
C-1	30 ± 30
A-1	35 ± 20

* Mean ± standard error

Source: Paine 1980

TABLE 2-5

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES COLLECTED FROM PONDS C-1 AND C-2 IN 1989

Analyte	Pond C-1 (SW-C1)	Pond C-2 (SW-C2)
Radionuclides (pCi/l)	Concentration[3] (pCi/l)	Concentration[3] (pCi/l)
Americium-241	0.01 ± 0.01	0.01 ± 0.01
Cesium-137	0.3 ± 0.5	0.3 ± 0.5
Gross Alpha	13.0 ± 8.0	3.0 ± 3.0
Gross Beta	9.0 ± 3.0	12.0 ± 3.0
Plutonium-239	0.02 ± 0.01	0.06 ± 0.02
Strontium-90	0.9 ± 0.5	3.5 ± 0.7
Tritium	530.0 ± 210.0	500.0 ± 210.0
Uranium-233/234	2.0 ± 0.4	0.8 ± 0.2
Uranium-235	0.1 ± 0.1	0.0 ± 0.1
Uranium-238	1.6 ± 0.3	0.7 ± 0.2
Radium 226	0.5 ± 0.3	N.D.
Uranium, Total[4]	3.2	N.D.
Metals	Concentration[3] (mg/l)	Concentration[3] (mg/l)
Iron	2.02	0.311
Magnesium	12.40[1]	11.70
Manganese	0.599	2.52
Zinc	0.228[2]	0.358[2]
Aluminum	1.42	N.D.
Mercury	0.0018	0.0003[2]
Strontium	N.D.	0.279
Calcium		
Sodium		
Organics	Concentration[3] (μg/l)	Concentration[3] (μg/l)
Bis(2-Ethylhexyl) Phthalate	1.0	N.D.
Phenol	3.0	15.0
Di-n-Butyl Phthalate	N.D.	17.0
Anions and Cations	Concentration[3] (mg/l)	Concentration[3] (mg/l)
Sulfide	1.0	1.0
Potassium	N.D.	8.49
Carbonate, Hydrogen	N.D.	190.0
Chloride	N.D.	37.0
Sulfate	N.D.	52.0
Nitrate/Nitrite	N.D.	0.07

TABLE 2-5
(Concluded)

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES COLLECTED FROM PONDS C-1 AND C-2 IN 1989

Analyte	Pond C-1 (SW-C1)	Pond C-2 (SW-C2)
Indicator	Concentration³ (mg/l)	Concentration³ (mg/l)
Total Dissolved Solids	N.D.	260.0

N.D. No data

Note: ¹ Concentration validated
² Concentration is acceptable with qualifications
³ Potential applicable or relevant and appropriate requirements for OU5 are presented in Section 3.0
⁴ No units

Source: (EG&G 1990d)

TABLE 2-6

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES SW-32, SW-36, AND SW-39 COLLECTED ALONG WOMAN CREEK IN 1989

Analyte	SW-32			SW-36			SW-39		
Radionuclides	Concentration[3] (pCi/l)			Concentration[3] (pCi/l)			Concentration[3] (pCi/l)		
Americium-241 (Filtered)	N.D.			0.01	±	0.01	N.D.		
Americium-241 (Unfiltered)	0.321	±	0.077	0.147	±	0.41	0.02	±	0.02
Cesium-137 (Filtered)	N.D.			0.6	±	0.6	N.D.		
Cesium-137 (Unfiltered)	0.4	±	0.8	0.2	±	0.5	0.1	±	0.6
Gross Alpha (Filtered)	0.0	±	3.0	17.0	±	10.0	3.0	±	3.0
Gross Alpha (Unfiltered)	3.0	±	4.0	18.0	±	10.0	1.0	±	2.0
Gross Beta (Filtered)	3.0	±	3.0	45.9	±	3.5	3.0	±	2.0
Gross Beta (Unfiltered)	5.0	±	5.0	25.0	±	5.0	4.0	±	2.0
Strontium-90 (Filtered)	1.09	±	0.49	0.3	±	0.5	N.D.		
Strontium-90 (Unfiltered)	0.2	±	0.5	0.38	±	0.32	0.5	±	0.3
Tritium	160.0	±	150.0	350.0	±	160.0	990.0	±	170.0
Uranium, Total[4]	1.8			35.58			0.5		
Uranium-233/234	1.0	±	0.3	7.96	±	1.59	0.3	±	0.2
Uranium-235 (Filtered)	N.D.			0.4	±	0.2	N.D.		
Uranium-235 (Unfiltered)	0.26	±	0.37	0.62	±	0.49	0.0	±	0.1
Uranium-238 (Filtered)	N.D.			17.0	±	1.0	N.D.		
Uranium-238 (Unfiltered)	0.84	±	0.64	27.0	±	2.9	0.3	±	0.2
Plutonium-239 (Unfiltered)	0.013	±	0.007	0.04	±	0.02	0.0	±	0.01
Radium-226 (Filtered)	N.D.			0.5	±	0.3	N.D.		
Radium-226 (Unfiltered)	N.D.			0.3	±	0.2	N.D.		
Metals	Concentration[4] (mg/l)			Concentration[4] (mg/l)			Concentration[4] (mg/l)		
Aluminum	24.80[1]			99.60[1]			N.D.		
Calcium	72.10[1]			173.0			28.0[1]		
Iron	22.20[1]			108.0			0.383[1]		
Magnesium	11.20[1]			57.70			7.22		
Manganese	0.622[1]			2.14			0.0585[2]		
Mercury	0.0003[2]			0.0011[2]			0.003		
Molybdenum	0.0231[1]			N.D.			0.0229[1]		
Sodium	23.10[1]			32.50[1]			22.90[2]		
Zinc	0.201			0.413			0.0222		
Barium	0.387[1]			1.47			N.D.		
Chromium	0.0222[1]			0.118			N.D.		
Copper	0.0252[1]			0.122			N.D.		
Lead	0.0248[1]			0.0840			N.D.		
Strontium	0.198			1.07			N.D.		
Tin	N.D.			0.198[2]			N.D.		
Lithium	N.D.			0.0780			N.D.		
Arsenic	N.D.			0.0094			N.D.		
Beryllium	N.D.			0.0078			N.D.		
Cobalt	N.D.			0.0618			N.D.		
Nickel	N.D.			0.105			N.D.		

TABLE 2-6
(Concluded)

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES SW-32, SW-36, AND SW-39 COLLECTED ALONG WOMAN CREEK IN 1989

Analyte	SW-32	SW-36	SW-39
Anions and Cations	Concentration[3] (mg/l)	Concentration[3] (mg/l)	Concentration[3] (mg/l)
Potassium	N.D.	15.10	N.D.
Sulfate	31.0[1]	130.0[1]	N.D.
Carbonate, Hydrogen	190.0[1]	200.0[1]	N.D.
Chloride	22.0[1]	55.0	N.D.
Nitrate/Nitrite	0.10[2]	N.D.	N.D.

Notes:
[1] Concentration validated
[2] Concentration is acceptable with qualifications
[3] Potential applicable or relevant and appropriate requirements for OU5 are presented in Section 3.0
[4] No units

Surface Water Locations can be found in Section 7.0 on Figure 7-2

Source: (EG&G 1990d)

2.4.5 Geology and Hydrology

The surficial units near Ponds C-1 and C-2 are primarily valley fill alluvium and colluvium. This is based on the lithology encountered in two alluvial monitoring wells (6486 and 6586) located slightly upstream of these ponds. In both these wells, the valley fill alluvium is approximately 7 to 9 feet thick and is a silty clayey gravel to clayey sand. The gravel is multicolored and is subangular to subrounded. Beneath these surficial deposits is the Arapahoe Formation. This unit is a slightly calcareous yellowish-orange to light olive-gray claystone, with some oxide staining. The shallow nature of the bedrock below ground surface is typical of those areas immediately adjacent to Woman Creek.

The valley fill alluvium may not be present beneath the Detention Ponds since the top 5 to 10 feet of the surficial materials were removed during construction of the ponds (Appendix A). The base of these ponds may be constructed in the Arapahoe Formation. The sediment that has been deposited in the ponds since their construction is unconsolidated and very fine grained.

Groundwater was encountered approximately 5 feet and 7 feet below the ground surface in wells 6586 and 6486, respectively, near Ponds C-1 and C-2 (Figure 2-7). Thus, only several feet of the valley fill alluvium is saturated in this area. It is likely that a thicker section of the alluvium is saturated in the spring, during the high-water stage. Groundwater within the alluvium is thought to flow principally to the east similar to Woman Creek's stream flow. The lithologic characteristics of the bedrock in this area, if similar to the nearby monitoring wells, is primarily a claystone. Little groundwater flow is, therefore, expected to occur through this unit. However, within the uppermost section of the Arapahoe Formation, as observed at various locations beneath the Plant site, subcropping sandstones have been encountered. Thus, further characterization of the Arapahoe Formation beneath these ponds is needed.

2.5 SURFACE DISTURBANCE (IHSS 209) AND THE SURFACE DISTURBANCES SOUTH OF THE ASH PIT AREA

2.5.1 Location and Description

Two separate surface disturbances will be described in this section: IHSS 209 and the surface disturbances south of the Ash Pits. IHSS 209 is located to the southeast of the Rocky Flats Plant security area, south of Woman Creek and approximately 1,000 feet southeast of Pond C-1 (IHSS 142.10) (Figure 2-7). This area was included as an IHSS because unknown activities took place in this area of shallow excavations and surface disturbances. This IHSS covers approximately 225,000 square feet (5.2 acres) and is located on a long narrow plateau bounded to the north, east and south by a uniform slope leading into the Woman Creek drainage. A dirt road transects this IHSS and loops near the eastern boundary. Three excavations are located within the boundary of this IHSS (Figure 2-7). Two depressions which periodically retain water are present near the northern and southwestern boundary of this unit (Figure 2-7).

A second surface disturbance area has been added to the OU5 investigation. This area is located 1,200 feet south of IHSS 133 and south of Woman Creek. This area consists of five former excavation areas (Figure 2-6). These surface disturbances were identified in aerial photographs taken between 1955 and 1988 (U.S. EPA 1988c). There is still surface evidence of some of these disturbances. Two former excavations trend along northeast-southwest axes (Figure 2-6). Each excavation is approximately 30 feet wide by 400 feet long. A horseshoe-shaped area, or the east area, is located northeast of the parallel excavations and a third excavation (3 feet wide by approximately 2 feet deep) is located to the southwest. This excavation trends in a north-south direction across the plateau. A west area is approximately 600 feet by 150 feet and is located upslope (southwest) from the other disturbances.

2.5.2 History

It is not known what activity or activities may have taken place at IHSS 209 or at the surface disturbances south of the Ash Pits. However, the time period in which these areas were disturbed can be estimated from aerial photographs.

IHSS 209 first appears as a disturbed area in a 1955 aerial photograph (U.S. EPA 1988b). The ground was disturbed both west and east of the dirt road; however, no obvious features or equipment can be seen in the photo (Figure 2-7). By 1961, three excavations existed within this IHSS. The depression located near the southwestern boundary of this IHSS appears as a pond in the 1980, 1983, and 1988 aerial photographs. The 1980 aerial photograph also reveals that the western half of the IHSS was beginning to revegetate. By 1988, the only recognizable features on or near this surface disturbance was the presence of the eastern-most excavation and the pond located near the northern boundary of this IHSS (Figure 2-7).

The east excavation area was the first area to be noted as active in the surface disturbances south of the Ash Pits. This was observed in a 1955 aerial photograph. The two parallel excavations became active prior to 1978, as they are visible in the 1978 photo. After 1983, the excavation areas started to revegetate. The west area, located approximately 400 feet southwest of the parallel excavations, became active prior to 1969 (U.S. EPA 1988b). This area is now backfilled with large rocks. The time these rocks were placed is unknown.

2.5.3 Nature of Contamination and Previous Investigations

No previous investigations have been performed near IHSS 209 or the surface disturbances south of the Ash Pit area. In addition, there are no nearby groundwater monitoring wells that can provide data on these areas.

2.5.4 Surface Drainage

IHSS 209 is located on a plateau. Surface runoff from this unit flows to the northwest, north, east, and south into Woman Creek drainage (Figure 2-7). Woman Creek is about 750 feet to the north of IHSS 209 and is about 140 feet lower in elevation. Since this IHSS is located atop a plateau, it receives little runoff from any upslope areas.

The surface disturbances south of the Ash Pit area are also located on a narrow plateau (Figure 2-6). Surface runoff flows to the north, northeast, or west, toward Woman Creek. Woman Creek is located approximately 400 feet to the north of these surface disturbances and is between 20 to 80 feet lower in elevation. This area, like IHSS 209, receives little surface runoff from any upslope areas.

2.5.5 Geology and Hydrology

The geology beneath and near IHSS 209 and the surface disturbances south of the Ash Pit area has been characterized based on the geographical location of the units, lithologic information obtained from a monitoring well drilled on a similar plateau area and from the surficial geological map of the OU5 area (Figure 1-5). As was encountered in the monitoring well (P416489), located 2,500 feet to the north-northeast of IHSS 209, the Rocky Flats Alluvium and the Arapahoe Formation are the geologic units that underlie these areas. The Rocky Flats Alluvium in the monitoring well is approximately 20-30 feet thick and consists of poorly sorted, multicolored, sandy gravelly clay to gravelly clayey sand. The Arapahoe Formation is a moderately to well sorted sandy silty claystone to claystone, with some oxide staining. It is likely that these formations underlie the surface disturbances since these plateau areas are characteristic of the deposition of Rocky Flats Alluvium on the surface of the Arapahoe Formation.

The characteristics of the hydrologic system(s) are unknown beneath these surface disturbances because of the lack of nearby wells. Groundwater probably occurs at the base of the Rocky Flats Alluvium just above the less-permeable Arapahoe Formation; however, further characterization of the nature of the Rocky Flats Alluvium and Arapahoe Formation is needed.

2.6 CONCEPTUAL MODELS

Phase I conceptual models for each IHSS and/or similar IHSSs were developed and are presented in the following subsections. The Phase I models are based on a review of the historical data and previous investigations conducted near each IHSS. In the following sections, the conceptual models will describe contaminant sources, the potential migration and exposure pathways, and potential receptors for each IHSS.

2.6.1 Original Landfill (IHSS 115)

The Original Landfill is located south of the west access road on a slope leading down to Woman Creek. This unit received approximately 2 million cubic feet of miscellaneous plant wastes during its operation. Plant wastes included such things as solvents, paints, paint thinners, oil, pesticides, and cleaners. Metals such as beryllium, uranium, lead, and chromium are also suspected to have been buried in the landfill. The potential source of contamination at this IHSS is the material buried in the landfill.

Air Pathway. The landfill was previously closed with a soil cover. However, erosion and sloughing have resulted in an irregular ground surface, and the quality and integrity of the cover is questionable; therefore, exposure by the air pathway should be considered. The potential receptors of emissions or wind-blown particulates from the Original Landfill are workers at Rocky Flats and animals in the proximity and downwind of this unit.

Surface Water Pathway. Surface water runoff from the landfill should not come in contact with the waste in this IHSS since there is a soil cover over the facility. However, because of the potentially unstable nature of this cover (as described above), the surface water pathway should be considered. Surface water flows north to south across this unit with the steep topography over the Original Landfill resulting in fairly rapid flow rates. Surface water runoff from most of this IHSS flows south into the SID, where it is diverted into Pond C-2 (IHSS 142.11). In Pond C-2 the water is monitored and treated before being discharged. After being discharged, the water is pumped through a pipeline to a diversion ditch (Broomfield Diversion Ditch), around Great Western Reservoir, and empties into Big Dry Creek. Runoff from the small portion of the landfill that is south of the SID flows south into Woman Creek, where it subsequently flows east into Detention Pond C-1 and then into Woman Creek. The potential human receptors are off-site surface water users downgradient, east of Indiana Street along the Woman Creek and Walnut Creek drainages. Aquatic biota, birds, and mammals are potential on-site receptors. Monitoring of surface water prior to its discharge from Pond C-2 reduces the likelihood of human exposure to surface water contaminants from the Original Landfill.

Groundwater Pathway. Migration of contaminants by infiltration and percolation of water through the landfill into the groundwater is another likely migration pathway. The landfill has no bottom liner, and thus leachate can percolate through this unit and migrate into the groundwater. There are no groundwater wells within this IHSS, and thus the characteristics of the groundwater system beneath the landfill can only be estimated. Based on the limited nearby well control, the uppermost aquifer beneath the landfill is probably the Rocky Flats Alluvium, colluvial deposits and weathered Arapahoe Formation. Groundwater beneath the landfill likely flows to the south until it reaches Woman Creek where the groundwater flow direction changes to the east.

Water samples collected from a well downgradient from this IHSS detected radionuclides and metals (see Subsection 2.2.4). It is not known if the concentrations detected are characteristic of background conditions, contamination from other sources upgradient of the landfill, or contamination from a source in the landfill.

On-site animal or human receptors could contact groundwater surfacing in Woman Creek. Potential human receptors of the groundwater would be off-site groundwater users east of Indiana Street. This pathway is not as direct as the surface water or air pathways because of the slower movement of groundwater and the distance to receptors.

2.6.2 Ash Pits 1-4, Incinerator, and Concrete Wash Pad (IHSS 133)

The Incinerator, Ash Pits, and Concrete Wash Pad are located south of the west access road on a relatively flat, grassy area. The Incinerator was used to burn general plant wastes. Ashes from the Incinerator were placed in trenches or pits (Ash Pits 1 through 4) or pushed over the side of the hill into Woman Creek drainage and/or onto the Concrete Wash Pad. Along with general plant wastes, it is possible that uranium-238 was also burned and subsequently buried in the Ash Pits. Following shutdown of the Incinerator, the Ash Pits were covered with fill. The Concrete Wash Pad was principally used to dispose of waste concrete from concrete trucks involved in construction at the Rocky Flats Plant facility and as an area to wash concrete trucks. The source of contamination at the Ash Pits, if present, is the materials in the pits.

<u>Surface Water and Air Pathways</u>. Surface water runoff probably does not contact the wastes in these units because of the soil or concrete cover present. Similarly, release of contaminants into the air is also inhibited by covers over these units. Thus, these potential pathways will not be considered for these units.

<u>Groundwater Pathway</u>. The most likely migration pathway for potential contamination from IHSS 133 is the groundwater pathway. The permeable nature of the colluvial/alluvial deposits beneath this IHSS probably allow water to percolate through the Ash Pits into the groundwater (4 to 8 feet below ground surface). Beneath the Ash Pits the groundwater flows south toward Woman Creek where the flow direction changes to the east.

Water samples collected from a well downgradient from these IHSSs detected radionuclides and metals (see Subsection 2.3.4). It is not known if the concentrations detected are characteristic of background conditions, contamination from other sources upgradient of the Ash Pits, or contamination from a source in the Ash Pits.

On-site animal or human receptors could contact groundwater surfacing in Woman Creek. Other potential human receptors of the groundwater are off-site groundwater users east of Indiana Street, over 2 mile from the Ash Pits.

2.6.3 Ponds C-1 and C-2 (IHSSs 142.10 and 142.11)

Detention Ponds C-1 and C-2 along the Woman Creek drainage and the SID are used primarily to capture and control surface water runoff. Pond C-1 receives water from Woman Creek, while Pond C-2 receives water from the SID and, consequently, surface water runoff from the southern part of the production facilities. Historically, water and sediment samples from these ponds have occasionally contained low concentrations of radionuclides. These contaminants, however, have primarily been found in the bottom sediments of the ponds. Analytical data from water samples taken from Ponds C-1 and C-2 during several sampling periods in 1989 detected various radionuclides and other compounds (see Subsection 2.4.4). The potential sources of contamination at Ponds C-1 and C-2 are sediments and water in the ponds.

Air Pathway. The air pathway from these ponds is not considered to be a primary potential pathway since contaminated particulates are generally not available for wind-blown transportation. Contaminated sediments are generally beneath the water in the pond. VOCs, if present, could pose a concern through atmospheric emissions.

Surface Water Pathway. The surface water pathway is considered to be the most likely migration pathway from these detention ponds. Surface water enters Pond C-1 prior to discharging into Woman Creek, which flows eastward into Standley Lake and Mower Reservoirs, 4 miles to the east. Water detained in Pond C-2 is currently being treated prior to being discharged toward Great Western Reservoir, where it is diverted around the reservoir by the Broomfield Diversion Ditch and into Big Dry Creek. Discharges from Pond C-2 are monitored for contaminants to comply with an NPDES permit. Aquatic biota, birds, and mammals are potential on-site receptors of surface water. Potential off-site receptors of surface water from Ponds C-1 and C-2 are the off-site surface water users of Woman Creek or Big Dry Creek east of Indiana Street. This pathway is considered the most direct of the exposure pathways from these ponds since the surface water flow should be relatively rapid.

Groundwater Pathway. The groundwater pathway is also a potential pathway of concern. The ponds are not lined and migration and infiltration of surface water through the sediments and alluvium to the groundwater probably occurs. Groundwater flow in this area is likely to the east. Animal and human receptors could contact groundwater surfacing in Woman Creek. Other potential human receptors for the groundwater are off-site groundwater users east of Indiana Street. This pathway is not as direct as the surface water pathway because of the slower movement of groundwater, the distance to potential receptors, and because of the ability of the aquifer to retard and absorb potential contaminants.

2.6.4 Surface Disturbance (IHSS 209)

No field sampling investigations have been conducted at this IHSS and no waste disposal activities are known to have taken place. Thus, while exposure pathways exist for this IHSS, the presence of hazardous materials within this IHSS has not been proven.

Surface Water Pathway. This IHSS is located on a narrow plateau approximately 400 feet south of Woman Creek. Surface runoff flows from this unit to the northwest, north, east, and south, and eventually flows into Woman Creek. Subsequently, the migration of surface water runoff from this IHSS is a primary concern if surface contamination exists. The potential receptors to the surface water runoff are on-site animals and humans and surface water users east of Indiana Street.

Air Pathway. The air pathway may also be considered a potential pathway for contaminant migration since no cover is known to exist over this surface disturbance. However, it is not known if any contaminants are exposed on the surface. The potential receptors for the air pathway would primarily be animals and workers at Rocky Flats or downwind of the unit. This unit is located about ½ mile from the main plant site, where the majority of human activities take place.

Groundwater Pathway. Infiltration and percolation of water through this IHSS to the groundwater is also a potential migration pathway if contamination exists. The hydrogeologic characteristics are not known in this area (due to lack of wells or borings), however, groundwater likely flows to the north to Woman Creek and then east. Animal and human receptors could contact groundwater surfacing in Woman Creek. Other potential human receptors are likely to be the off-site groundwater users east of Indiana Street. This pathway is not as direct as the surface water or air pathways because of the slower movement of groundwater and the distance to receptors.

2.6.5 Surface Disturbance South of Ash Pits

No previous investigations have been performed at the surface disturbance, and there have been no reports of waste disposal activities or spills. The presence or absence of hazardous substances will be investigated during the Phase I Investigation. If contamination exists, the potential exposure pathways and receptors for the surface disturbance are similar to the ones described above for IHSS 209 since both areas are located on plateaus south of Woman Creek.

Surface Water Pathway. This disturbance is located on a plateau approximately 400 feet south of Woman Creek. Surface runoff flows from this unit to the north, and eventually flows into Woman Creek. Subsequently, the migration of surface water runoff from this IHSS is a primary concern if surface contamination exists. The potential receptors to the surface water runoff are on-site animals and humans and surface water users east of Indiana Street.

Air Pathway. The air pathway may also be considered a potential pathway for contaminant migration since no cover is known to exist over this surface disturbance. However, it is not known if any contaminants are exposed on the surface. The potential receptors for the air pathway would primarily be animals and workers at Rocky Flats or downwind of the unit. This unit is located about ½ mile from the main plant site, where the majority of human activities take place.

Groundwater Pathway. Infiltration and percolation of water through this disturbance to the groundwater is also a potential migration pathway if contamination exists. The hydrogeologic characteristics are not known in this area (due to lack of wells or borings), however, groundwater likely flows to the north to Woman Creek and then east. Animal and human receptors could contact groundwater surfacing in Woman Creek. Other potential human receptors are likely to be the off-site groundwater users east of Indiana Street. This pathway is not as direct as the surface water or air pathways because of the slower movement of groundwater and the distance to receptors.

3.0
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section provides a preliminary identification of potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for surface water and groundwater at Operable Unit 5 (OU5). The summary of possible ARARs presented is based on current federal and state health and environmental statutes and regulations and the chemicals suspected to be present at OU5. The preliminary identification and examination of potential ARARs will provide for the use of appropriate analytical detection limits during the RFI/RI. As data become available during the Phase I RI, specific ARARs will be proposed for OU5. The Corrective Measures Study (CMS)/Feasibility Study (FS) report will further address chemical-specific ARARs as well as action- and location-specific ARARs in the development and evaluation of remedial alternatives.

3.1 THE ARAR BASIS

The basis for ARARs is cited in Section 121(d) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), which requires that Fund-financed, enforcement, and federal facility remedial actions comply with applicable or relevant and appropriate federal laws or promulgated state laws, whichever is more stringent. For the purposes of identification and notification of promulgated state standards, the term "promulgated" means that the standards are of general applicability and are legally enforceable (NCP, 40 CFR 300.400(g)(4)). Colorado Department of Health (CDH) Water Quality Control Commission (WQCC) groundwater standards are to be considered (TBC) since they are not yet enforceable.

3.2 THE ARAR PROCESS

A screening and analysis process will be used to determine the potential ARARs to be applied to OU5. The analysis will address compliance with chemical-, location-, and action-specific ARARs in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The screening process will consider relevant and appropriate requirements in the same manner as applicable requirements. When more than one ARAR is identified, the most stringent ARAR will be used.

The first step in identifying potential ARARs will occur after the initial scoping and site characterization and will involve the analysis of the chemicals present at the site and any location-specific characteristics at the site. Once the chemicals have been identified, the presence of absence or chemical-specific ARARs will be determined. Chemical-specific ARARs will be derived primarily from federal and state health and environmental statutes and regulations, including the following:

- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) applied to both surface and groundwater

- Clean Water Act (CWA) Water Quality Criteria (WQC) applied to surface water

- RCRA Subpart F groundwater concentration limits (40 CFR 264.94) - applied to groundwater

- Colorado Department of Health (CDH) surface water standards for Woman Creek and Walnut Creek (5 CCR 1002-8, Section 3.8.29, Final Rule Effective March 30, 1990) - applied to surface water

- CDH WQCC proposed statewide and classified groundwater area standards (5 CCR 1002-8, Section 3.11) - applied to groundwater as TBC

A summary of chemical-specific standards or possible ARARs based on the above regulations and contaminants that may be found at OU5 is presented in Table 3-1, Groundwater Quality Standards; Table 3-2, Federal Surface Water Quality Standards; and Table 3-3, State Surface Water Quality Standards. These potential chemical-specific ARARs and accompanying regulations will be screened to determine their jurisdictional requirements and applicability to OU5. If the requirements are not applicable, they will be further screened to determine whether they are relevant and appropriate to the particular site-specific conditions at OU5. Where ARARs do not exist for a particular chemical or where existing ARARs are not protective of human health or the environment, to-be-considered (TBC) criteria, guidances, proposed standards, and advisories will be evaluated for use. Standards identified as potential ARARs, as well as TBC criteria, will be analyzed according to the procedures outlined in the Superfund Public Health Evaluation Manual (U.S. EPA 1986a), NCP, and CERCLA Compliance with Other Laws Manual (U.S. EPA 1989).

3.2.1 ARARs

"Applicable requirements," as defined in 40 CFR 300.5, are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable." "Relevant and appropriate requirements," also defined in 40 CFR 300.5, are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Dissolved Oxygen	Field Parameter										
pH	Field Parameter	6.5-8.5 *							6.5-8.5	6.5-8.5	
Specific Conductance	Field Parameter										
Temperature	Field Parameter										
Total Dissolved Solids	Indicator	500 mg/l *									400 mg/l (1)
Bicarbonate	Anion										
Carbonate	Anion										
Chloride	Anion	250 mg/l *							250 mg/l		
Fluoride	Anion	4 mg/l, 2 mg/l*		4 mg/l				4 mg/l		2 mg/l	
N as Nitrate	Anion	10 mg/l						10.0 mg/l			
N as Nitrate+Nitrite	Anion		10 mg/l		10 mg/l					100 mg/l	
N as Nitrite	Anion		1 mg/l		1 mg/l			1.0 mg/l		10 mg/l	
Potassium	Anion										
Sulfate	Anion	250 mg/l *							250 mg/l		
Aluminum	Metal		0.05 to 0.2 mg/l*							5.0 mg/l	
Antimony	Metal										
Arsenic	Metal	50 ug/l				50 ug/l		50 ug/l		100 ug/l	
Arsenic III	Metal										
Arsenic V	Metal										
Barium	Metal	1.0 mg/l				1 mg/l		1.0 mg/l			
Beryllium	Metal									100 ug/l	
Cadmium	Metal	10 ug/l	5 ug/l		5 ug/l	10 ug/l		10 ug/l		10 ug/l	
Calcium	Metal										
Chromium	Metal	50 ug/l	100 ug/l		100 ug/l	50 ug/l		50 ug/l		100 ug/l	
Chromium III	Metal										
Chromium VI	Metal										
Cobalt	Metal									50 ug/l	
Copper	Metal	1 mg/l *							1 mg/l	200 ug/l	

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

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							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Cyanide	Metal							200 ug/l			
Iron	Metal	300 ug/l *							300 ug/l	5 mg/l	
Lead	Metal	50 ug/l				50 ug/l		50 ug/l		100 ug/l	
Magnesium	Metal										
Manganese	Metal	50 ug/l *							50 ug/l	200 ug/l	
Mercury	Metal	2 ug/l			2 ug/l	2 ug/l		2 ug/l		10 ug/l	
Molybdenum	Metal										
Nickel	Metal									200 ug/l	
Selenium	Metal	10 ug/l	50 ug/l		50 ug/l	10 ug/l		10 ug/l		20 ug/l	
Silver	Metal	50 ug/l	100 ug/l			50 ug/l		50 ug/l			
Sodium	Metal										
Thallium	Metal										
Tin	Metal										
Titanium	Metal										
Tungsten	Metal										
Vanadium	Metal									100 ug/l	
Zinc	Metal	5 mg/l *							5 mg/l	2.0 mg/l	
Americium 241	Radionuclide										
Cesium 137	Radionuclide										
Cesium 134	Radionuclide						80 pCi/l (2)	80 pCi/l			
Gross Alpha	Radionuclide	15 pCi/l						15 pCi/l			
Gross Beta	Radionuclide	4 mrem/yr						4 mrem/yr			
Plutonium 238+239+240	Radionuclide						15 pCi/l (2)	15 pCi/l			
Radium 226+228	Radionuclide	5 pCi/l					5 pCi/l (2)	5 pCi/l			
Strontium 90	Radionuclide						8 pCi/l (2)	8 pCi/l			
Thorium 230+232	Radionuclide						60 pCi/l (2)	60 pCi/l			
Tritium	Radionuclide						20,000 pCi/l(2)	20,000 pCi/l			
Uranium 233+234	Radionuclide										

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

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							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Uranium 235	Radionuclide										
Uranium 238	Radionuclide										
Uranium (total)	Radionuclide										
1,1-Dichloroethane	Volatile										
1,1-Dichloroethene	Volatile	7 ug/l		7 ug/l			7 ug/l				
1,1,1-Trichloroethane	Volatile	200 ug/l		200 ug/l			200 ug/l				
1,1,2,2-Tetrachloroethane	Volatile										
1,1,2-Trichloroethane	Volatile						28 ug/l (6)				
1,2-Dichloroethane	Volatile	5 ug/l		0 ug/l			5 ug/l				
1,2-Dichloroethene	Volatile						70 ug/l				
1,2-Dichloropropane	Volatile		5 ug/l		0 ug/l		560 ng/l				
2-Butanone	Volatile										
2-Hexanone	Volatile										
4-Methyl-2-pentanone	Volatile										
Acetone	Volatile										
Benzene	Volatile	5 ug/l		0 mg/l							
Benzo(a)anthracene	Volatile										
Benzo(a)pyrene	Volatile										
Benzo(b)fluoranthene	Volatile										
Benzo(g,h,i)perylene	Volatile										
Benzo(k)fluoranthene	Volatile										
Bromodichloromethane	Volatile										
Bromoform	Volatile										
Bromomethane	Volatile										
Chlorinated Benzenes	Volatile										
Chlorobenzene	Volatile						300 ug/l				
Chloroethane	Volatile										
Chloroform	Volatile	Tot THM**					Tot THM**				

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
		SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type						Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Chloromethane	Volatile	<100 ug/l					<100 ug/l				
cis-1,3-Dichloropropene	Volatile										
Dibromochloromethane	Volatile										
Ethyl Benzene	Volatile		0.7 mg/l		0.7 mg/l		680 ug/l				
Fluoranthene	Volatile										
Haloethers	Volatile										
Halomethanes	Volatile										
Indeno(1,2,3-cd)pyrene	Volatile										
Methylene Chloride	Volatile										
Phenanthrene	Volatile										
Phenol	Volatile							1 ug/l			
Polynuclear Aromatic Hydrocarbons	Volatile										
Pyrene	Volatile										
Styrene	Volatile		0.1 mg/l		0.1 mg/l						
Tetrachloroethanes	Volatile										
Tetrachloroethene	Volatile		5 ug/l		0 ug/l		10 ug/l				
Total Xylenes	Volatile		10 mg/l		10 mg/l						
trans-1,3-Dichloropropene	Volatile										
Trichloroethanes	Volatile										
Trichloroethene	Volatile	5 ug/l		0 ug/l			5 ug/l				
Vinyl Acetate	Volatile										
1,2-Dichlorobenzene	Semi-Volatile						620 ug/l				
1,3-Dichlorobenzene (ortho)	Semi-Volatile						620 ug/l				
1,4-Dichlorobenzene (para)	Semi-Volatile	75 ug/l		75 ug/l			75 ug/l				
1,2,4-Trichlorobenzene	Semi-Volatile										
2-Chloronaphthalene	Semi-Volatile										

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
2-Chlorophenol	Semi-Volatile										
2-Methylnaphthalene	Semi-Volatile										
2-Methylphenol	Semi-Volatile										
2-Nitroaniline	Semi-Volatile										
2-Nitrophenol	Semi-Volatile										
2,4-Dichlorophenol	Semi-Volatile						21 ug/l				
2,4-Dimethylphenol	Semi-Volatile										
2,4-Dinitrophenol	Semi-Volatile										
2,4-Dinitrotoluene	Semi-Volatile										
2,4,5-*Trichlorophenol*	*Semi-Volatile*						700 ug/l				
2,4,6-Trichlorophenol	Semi-Volatile										
3-Nitroaniline	Semi-Volatile										
3,3-Dichlorobenzidine	Semi-Volatile										
4-Bromophenyl Phenylether	Semi-Volatile										
4-Chloroaniline	Semi-Volatile										
4-Chlorophenyl Phenyl Ether	Semi-Volatile										
4-Chloro-3-methylphenol	Semi-Volatile										
4-Methylphenol	Semi-Volatile										
4-Nitroaniline	Semi-Volatile										
4-Nitrophenol	Semi-Volatile										
4,6-Dinitro-2-methylphenol	Semi-Volatile										
Acenaphthene	Semi-Volatile										
Acetone	Semi-Volatile										
Acrylonitrile	Semi-Volatile										
Aldrin	Semi-Volatile						2 ng/l				
Anthracene	Semi-Volatile										
Atrazine	Semi-Volatile		3 ug/l		3 ug/l		0.2 ng/l				
Benzidine	Semi-Volatile							0.1 ug/l			
Benzoic Acid	Semi-Volatile										

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Benzyl Alcohol	Semi-Volatile										
bis(2-Chloroethoxy)methane	Semi-Volatile										
bis(2-Chloroethyl)ether	Semi-Volatile						30 ng/l				
bis(2-Chloroisopropyl)ether	Semi-Volatile										
bis(2-Ethylhexyl)phthalate	Semi-Volatile										
Butyl Benzylphthalate	Semi-Volatile										
Carbon Disulfide	Semi-Volatile										
Carbon Tetrachloride	Semi-Volatile	5 ug/l		0 mg/l			5 ug/l				
Chlorinated Benzenes	Semi-Volatile										
Chlorinated Ethers	Semi-Volatile										
Chlorinated Napthalenes	Semi-Volatile										
Chloroalkylethers	Semi-Volatile										
Chlorodane	Semi-Volatile		2 ug/l				0.03 ug/l	4 ng/l			
Chlorophenol	Semi-Volatile							1 ug/l			
DDT	Semi-Volatile						0.1 ug/l				
DDE	Semi-Volatile										
DDD	Semi-Volatile										
Dibenzofuran	Semi-Volatile										
Dibenz(a,h)anthracene	Semi-Volatile										
Dichlorobenzenes	Semi-Volatile										
Dichlorobenzidine	Semi-Volatile						2 ng/l				
Dichloroethenes	Semi-Volatile										
Dichloromethane	Semi-Volatile										
Dieldrin	Semi-Volatile										
Diethylphthalate	Semi-Volatile										
Dimethylphthalate	Semi-Volatile										
Di-n-butylphthalate	Semi-Volatile										
Dinitrotoluene	Semi-Volatile										
Di-n-octylphthalate	Semi-Volatile										

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
		SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type						Tables A & B *Statewide*	Table 1 Human Health	Table 2 Secondary *Drinking*	Table 3 Agricultural	Table 4 TDS Standard
Dioxin	Semi-Volatile						0.22 pg/l				
Endosulfan I	Semi-Volatile										
Endosulfan II	Semi-Volatile										
Endosulfan Sulfate	Semi-Volatile										
Endrin	Semi-Volatile	0.2 ug/l					0.2 ug/l	0.2 ug/l			
Endrin Ketone	Semi-Volatile										
Fluorene	Semi-Volatile										
Halomethanes	Semi-Volatile	0.10 mg/l					100 ug/l				
Heptachlor	Semi-Volatile		0.4 ug/l				8 ng/l				
Heptachlor Epoxide	Semi-Volatile		0.2 ug/l				4 ng/l				
Hexachlorobenzene	Semi-Volatile						0.02 ug/l				
Hexachlorobutadiene	Semi-Volatile						14 ug/l (6)				
Hexachlorocyclopentadiene	Semi-Volatile						49 ug/l (6)				
Hexachlorocyclohexane, Alpha	Semi-Volatile										
Hexachlorocyclohexane, Beta	Semi-Volatile										
Hexachlorocyclohexane, (Lindane) Gama	Semi-Volatile	4 ug/l	0.2 ug/l		0.2 ug/l		4 ug/l	4 ug/l			
Hexachlorocyclohexane, Technical	Semi-Volatile										
Hexachloroethane	Semi-Volatile										
Isophorone	Semi-Volatile						1.05 mg/l (6)				
Methoxychlor	Semi-Volatile	0.1 mg/l	0.04 mg/l		0.04 mg/l		100 ug/l	100 ug/l			
Naphthalene	Semi-Volatile										
Nitrobenzene	Semi-Volatile						3.5 ug/l (6)				
Nitrophenols	Semi-Volatile										
Nitrosamines	Semi-Volatile										
Nitrosodibutylamine	Semi-Volatile										
Nitrosodiethylamine	Semi-Volatile										
Nitrosodimethylamine	Semi-Volatile										
Nitrosopyrrolidine	Semi-Volatile										
N-Nitrosodiphenylamine	Semi-Volatile										

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU5, WOMAN CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
		SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type						Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
N-Nitroso-di-n-dipropylamine	Semi-Volatile										
PCBs	Semi-Volatile		0.5 ug/l				5 ng/l				
Pentachlorinated Ethanes	Semi-Volatile										
Pentachlorophenol	Semi-Volatile										
Phthalate Esters	Semi-Volatile										
Simazine	Semi-Volatile										
Toluene	Semi-Volatile		1 mg/l		1 mg/l		2.42 mg/l				
Toxaphene	Semi-Volatile		3 ug/l				5 ug/l	5 ug/l			
Vinyl Chloride	Semi-Volatile	2 ug/l		0 ug/l			2 ug/l				

EXPLANATION OF TABLE

* = secondary maximum contaminant level
** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

CDH = Colorado Department of Health
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
WQCC = Water Quality Control Commission

(1) TDS standard - see Table 4 in (d)
(2) radionuclide standards - see sec. 3.11.5(c)2 in (d)

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526)
(c) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, August 1988
(d) CDH/Water Quality Control Commission, The Basic Standards for Ground Water, 3.11.0 (5 CCR 1002-8) 1/5/1987 amended 9/11/1990

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Dissolved Oxygen	Field Parameter					5.0 mg/l			
pH	Field Parameter	6.5-8.5 *					6.5-9		
Specific Conductance	Field Parameter								
Temperature	Field Parameter					SS	SS		
Total Dissolved Solids	Indicator	500 mg/l *				SS	SS	250 mg/l	
Bicarbonate	Anion								
Carbonate	Anion								
Chloride	Anion	250 mg/l *							
Flouride	Anion	4 mg/l, 2 mg/l*		4 mg/l					
N as Nitrate	Anion	10 mg/l			10 mg/l			10 mg/l	
N as Nitrate+Nitrite	Anion		10 mg/l		10 mg/l				
N as Nitrite	Anion		1 mg/l		1 mg/l				
Potassium	Anion								
Sulfate	Anion	250 mg/l *							
Aluminum	Metal		0.05 to 0.2 mg/l*						
Antimony	Metal					9 mg/l	1.6 mg/l	146 ug/l	45 mg/l
Arsenic	Metal	50 ug/l						2.2 ng/l	17.5 ng/l
Arsenic III	Metal					360 ug/l	190 ug/l		
Arsenic V	Metal					850 ug/l	48 ug/l		
Barium	Metal	1 mg/l						1 mg/l	
Beryllium	Metal					130 ug/l	5.3 ug/l	6.8 ng/l**	117 ng/l**
Cadmium	Metal	10 ug/l	5 ug/l		5 ug/l	3.9 ug/l (3)	1.1 ug/l (3)	10 ug/l	
Calcium	Metal								
Chromium	Metal	50 ug/l	100 ug/l		100 ug/l				
Chromium III	Metal					1.7 mg/l	210 ug/l	170 mg/l	3433 mg/l
Chromium VI	Metal					16 ug/l	11 ug/l	50 ug/l	
Cobalt	Metal								
Copper	Metal	1 mg/l *				18 ug/l (3)	12 ug/l (3)		
Cyanide	Metal					22 ug/l	5.2 ug/l	200 ug/l	

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA Water Quality Criteria for Protection of Human Health (c) Water and Fish Ingestion	CWA Water Quality Criteria for Protection of Human Health (c) Fish Consumption Only
Iron	Metal	300 ug/l *					1.0 mg/l	300 ug/l	
Lead	Metal	50 ug/l				82 ug/l (3)	3.2 ug/l (3)	50 ug/l	
Magnesium	Metal								
Manganese	Metal	50 ug/l *						50 ug/l	100 ug/l
Mercury	Metal	2 ug/l			2 ug/l	2.4 ug/l	12 ng/l	144 ng/l	146 ng/l
Molybdenum	Metal								
Nickel	Metal					1.4 mg/l (3)	160 ug/l (3)	13.4 ug/l	100 ug/l
Selenium	Metal	10 ug/l	50 ug/l		50 ug/l	260 ug/l	36 ug/l	10 ug/l	
Silver	Metal	50 ug/l	100 ug/l			4.1 ug/l (3)	120 ng/l	50 ug/l	
Sodium	Metal								
Thallium	Metal					1.4 mg/l (1)	40 ug/l (1)	13 ug/l	48 ug/l
Tin	Metal								
Titanium	Metal								
Tungsten	Metal								
Vanadium	Metal								
Zinc	Metal	5 mg/l *				120 ug/l (3)	110 ug/l (3)		
Americium 241	Radionuclide								
Cesium 137	Radionuclide								
Cesium 134	Radionuclide								
Gross Alpha	Radionuclide	15 pCi/l							
Gross Beta	Radionuclide	4 mrem/yr							
Plutonium 238+239+240	Radionuclide								
Radium 226+228	Radionuclide	5 pCi/l							
Strontium 90	Radionuclide								
Thorium 230+232	Radionuclide								
Tritium	Radionuclide								
Uranium 233+234	Radionuclide								
Uranium 235	Radionuclide								
Uranium 238	Radionuclide								

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE
FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Uranium (total)	Radionuclide								
1,1-Dichloroethane	Volatile								
1,1-Dichloroethene	Volatile	7 ug/l		7 ug/l					
1,1,1-Trichloroethane	Volatile	200 ug/l		200 ug/l				18.4 mg/l	1.03 g/l
1,1,2,2-Tetrachloroethane	Volatile						2.4 mg/l (1)	170 ng/l**	10.7 ug/l**
1,1,2-Trichloroethane	Volatile						9.4 mg/l (1)	600 ng/l**	41.8 ug/l**
1,2-Dichloroethane	Volatile	5 ug/l		0 ug/l		118 mg/l (1)	20 mg/l (1)	940 ng/l**	243 ug/l**
1,2-Dichloroethene	Volatile								
1,2-Dichloropropane	Volatile		5 ug/l		0 ug/l	23 mg/l (1)	5.7 mg/l (1)		
2-Butanone	Volatile								
2-Hexanone	Volatile								
4-Methyl-2-pentanone	Volatile								
Acetone	Volatile								
Benzene	Volatile	5 ug/l		0 mg/l		5.3 mg/l (1)		660 ng/l**	40 ug/l**
Benzo(a)anthracene	Volatile								
Benzo(a)pyrene	Volatile								
Benzo(b)fluoranthene	Volatile								
Benzo(g,h,i)perylene	Volatile								
Benzo(k)fluoranthene	Volatile								
Bromodichloromethane	Volatile								
Bromoform	Volatile								
Bromomethane	Volatile								
Chlorinated Benzenes	Volatile					250 ug/l (1)	50 ug/l (1)		
Chlorobenzene	Volatile								
Chloroethane	Volatile								
Chloroform	Volatile	Tot THM <100 ug/l (2)				28.9 mg/l (1)	1.24 mg/l (4)	0.19 ug/l**	15.7 ug/l **

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Chloromethane	Volatile								
cis-1,3-Dichloropropene	Volatile					6.06 mg/l (1)	244 ug/l (1)	87 ug/l	14.1 mg/l
Dibromochloromethane	Volatile								
Ethyl Benzene	Volatile		0.7 mg/l		0.7 mg/l	32 mg/l (1)		1.4 mg/l	3.28 mg/l
Fluoranthene	Volatile					3.98 mg/l (1)		42 ug/l	54 ug/l
Haloethers	Volatile					380 ug/l (1)	122 ug/l (1)		
Halomethanes	Volatile					11 mg/l (1)		190 ng/l**	15.7 ug/l**
Indeno(1,2,3-cd)pyrene	Volatile								
Methylene Chloride	Volatile								
Phenanthrene	Volatile								
Phenol	Volatile					10.2 mg/l (1)	2.56 mg/l (1)	3.5 mg/l	
Polynuclear Aromatic Hydrocarbons	Volatile							2.8 ng/l**	31.1 ng/l**
Pyrene	Volatile								
Styrene	Volatile		0.1 mg/l		0.1 mg/l				
Tetrachloroethanes	Volatile					9.32 mg/l (1)			
Tetrachloroethene	Volatile		5 ug/l		0 ug/l	5.28 mg/l (1)	840 ug/l (1)	800 ng/l**	8.85 ug/l**
Total Xylenes	Volatile		10 mg/l		10 mg/l				
trans-1,3-Dichloropropene	Volatile					6.06 mg/l (1)	244 ug/l (1)	87 ug/l	14.1 mg/l
Trichloroethanes	Volatile		0.2 mg/l			18 mg/l (1)			
Trichloroethene	Volatile	5 ug/l		0 ug/l		45 mg/l (1)	21.9 mg/l (1)	2.7 ug/l**	80.7 ug/l**
Vinyl Acetate	Volatile								
1,2-Dichlorobenzene	Semi-Volatile		0.6 mg/l						
1,3-Dichlorobenzene (ortho)	Semi-Volatile		0.6 mg/l		0.6 mg/l				
1,4-Dichlorobenzene (para)	Semi-Volatile	75 ug/l		75 ug/l					
1,2,4-Trichlorobenzene	Semi-Volatile								
2-Chloronaphthalene	Semi-Volatile								
2-Chlorophenol	Semi-Volatile					4.36 mg/l (1)	2.0 mg/l (1)		
2-Methylnaphthalene	Semi-Volatile								

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

		SDWA Maximum Contaminant Level	SDWA Maximum Contaminant Level TBCs	SDWA Maximum Contaminant Level Goal	SDWA Maximum Contaminant Level Goal TBCs	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
Parameter	Type	(a)	(b)	(a)	(b)	Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
2-Methylphenol	Semi-Volatile								
2-Nitroaniline	Semi-Volatile								
2-Nitrophenol	Semi-Volatile								
2,4-Dichlorophenol	Semi-Volatile					2.02 mg/l (1)	365 ug/l (1)	3.09 mg/l	
2,4-Dimethylphenol	Semi-Volatile					2.12 mg/l (1)			
2,4-Dinitrophenol	Semi-Volatile								
2,4-Dinitrotoluene	Semi-Volatile							110 ng/l**	9.1 ug/l**
2,4,5-Trichlorophenol	Semi-Volatile							2.8 mg/l	
2,4,6-Trichlorophenol	Semi-Volatile						970 ug/l (1)	1.2 ug/l**	3.6 ug/l**
3-Nitroaniline	Semi-Volatile								
3,3-Dichlorobenzidine	Semi-Volatile							0.01 ug/l	0.02 ug/l
4-Bromophenyl Phenylether	Semi-Volatile								
4-Chloroaniline	Semi-Volatile								
4-Chlorophenyl Phenyl Ether	Semi-Volatile								
4-Chloro-3-methylphenol	Semi-Volatile					30 ug/l (1)			
4-Methylphenol	Semi-Volatile								
4-Nitroaniline	Semi-Volatile								
4-Nitrophenol	Semi-Volatile					230 ug/l (1)	150 ug/l (1)		
4,6-Dinitro-2-methylphenol	Semi-Volatile								
Acenaphthene	Semi-Volatile					1.7 mg/l (1)	520 ug/l (1)		
Acetone	Semi-Volatile								
Acrylonitrile	Semi-Volatile								
Aldrin	Semi-Volatile					3.0 ug/l		0.074 ng/l	0.079 ng/l
Atrazine	Semi-Volatile		3 ug/l		3 ug/l				
Benzidine	Semi-Volatile								
Benzoic Acid	Semi-Volatile								
Benzyl Alcohol	Semi-Volatile								
bis(2-Chloroethoxy)methane	Semi-Volatile								
bis(2-Chloroethyl)ether	Semi-Volatile							30 ng/l**	1.36 ug/l **
bis(2-Chloroisopropyl)ether	Semi-Volatile							34.7 ug/l	4.36 mg/l

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE
FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA Water Quality Criteria for Protection of Human Health (c) Water and Fish Ingestion	CWA Water Quality Criteria for Protection of Human Health (c) Fish Consumption Only
bis(2-Ethylhexyl)phthalate	Semi-Volatile							15 mg/l	50 mg/l
Butyl Benzylphthalate	Semi-Volatile								
Carbon Disulfide	Semi-Volatile								
Carbon Tetrachloride	Semi-Volatile	5 ug/l		0 mg/l		35.2 mg/l (1)		400 ng/l**	6.94 ug/l**
Chlorinated Benzenes	Semi-Volatile					250 ug/l	50 ug/l		
Chlorinated Ethers	Semi-Volatile								
Chlorinated Napthalenes	Semi-Volatile					1.6 mg/l (1)			
Chloroalkylethers	Semi-Volatile					238 mg/l (1)			
Chlorodane	Semi-Volatile		2 ug/l			24 ug/l	4.3 pg/l	0.46 ng/l	0.48 ng/l
Chlorophenol	Semi-Volatile								
DDT	Semi-Volatile					1.1 ug/l	1 pg/l	24 pg/l	24 pg/l
DDE	Semi-Volatile					1.05 mg/l			
DDD	Semi-Volatile					0.05 ug/l			
Dichlorobenzidine	Semi-Volatile							0.01/ug/l	0.02 ug/l
Dibenzofuran	Semi-Volatile								
Dibenz(a,h)anthracene	Semi-Volatile								
Dichlorobenzenes	Semi-Volatile					1.12 mg/l (1)	763 ug/l (1)	400 ug/l	2.6 mg/l
Dichloroethenes	Semi-Volatile					11.6 mg/l (1)		33 ng/l**	1.85 ug/l**
Dichloromethane	Semi-Volatile								
Dieldrin	Semi-Volatile					2.5 ug/l	1.9 pg/l	0.07 ng/l	76 pg/l
Diethylphthalate	Semi-Volatile							350 mg/l	1.8 g/l
Dimethylphthalate	Semi-Volatile							313 mg/l	2.9 g/l
Di-n-butylphthalate	Semi-Volatile								
Dinitrotoluene	Semi-Volatile					330 ug/l (1)	230 ug/l (1)	70 ug/l	14.3 mg/l
Di-n-octylphthalate	Semi-Volatile								
Dioxin	Semi-Volatile					0.01 ug/l	10 pg/l	13 pg/l	14 pg/l
Endosulfan I	Semi-Volatile					0.22 ug/l	56 ng/l	74 ug/l	159 ug/l
Endosulfan II	Semi-Volatile								
Endosulfan Sulfate	Semi-Volatile								
Endrin	Semi-Volatile	0.2 ug/l				0.18 ug/l	2.3 ng/l	1 ug/l	

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Endrin Ketone	Semi-Volatile								
Fluorene	Semi-Volatile								
Halomethanes	Semi-Volatile	0.10 mg/l				11 mg/l		0.19 ug/l	15.7 ug/l
Heptachlor	Semi-Volatile		0.4 ug/l			0.52 ug/l	3.8 ng/l	0.28 ng/l	0.29 ng/l
Heptachlor Epoxide	Semi-Volatile		0.2 ug/l						
Hexachlorobenzene	Semi-Volatile							0.72 ng/l**	0.74 ng/l**
Hexachlorobutadiene	Semi-Volatile					90 ug/l (1)	9.3 ug/l (1)	450 ng/l**	50 ug/l**
Hexachlorocyclohexane, Alpha	Semi-Volatile							9.2 ng/l	31 ng/l
Hexachlorocyclohexane, Beta	Semi-Volatile							16.3 ng/l	54.7 ng/l
Hexachlorocyclohexane, (Lindane) Gama	Semi-Volatile	4 ug/l	0.2 ug/l		0.2 ug/l	2.0 ug/l	0.08 ug/l		
Hexachlorocyclohexane, Technical	Semi-Volatile							12.3 ng/l	41.4 ng/l
Hexachlorocyclopentadiene	Semi-Volatile					7 ug/l (1)	5.2 ug/l (1)	206 ug/l	
Hexachloroethane	Semi-Volatile					0.980 ug/l (1)	0.54 ug/l (1)	1.9 ug/l	8.74 ug/l
Isophorone	Semi-Volatile					117 mg/l (1)		5.2 mg/l	520 mg/l
Methoxychlor	Semi-Volatile	0.1 mg/l	0.04 mg/l		0.04 mg/l		0.03 ug/l	0.1 mg/l	
Naphthalene	Semi-Volatile					2.3 mg/l (1)	620 ug/l (1)		
Nitrobenzene	Semi-Volatile					27 mg/l (1)		19.8 mg/l	
Nitrophenols	Semi-Volatile					230 ug/l (1)	150 ug/l (1)		
Nitrosamines	Semi-Volatile					5.85 mg/l (1)			
Nitrosodibutylamine	Semi-Volatile							6.4 ng/l	587 ng/l
Nitrosodiethylamine	Semi-Volatile							0.8 ng/l	1.24 ug/l
Nitrosodimethylamine	Semi-Volatile							14 ng/l	16 ug/l
Nitrosopyrrolidine	Semi-Volatile							16 ng/l	91.9 ug/l
N-Nitrosodiphenylamine	Semi-Volatile							4.9 ug/l **	16.1 ug/l **
N-Nitroso-di-n-dipropylamine	Semi-Volatile								
PCBs	Semi-Volatile		0.5 ug/l			20 ug/l	14 ng/l	79 pg/l	79 pg/l
Pentachlorinated Ethanes	Semi-Volatile					7.24 mg/l (1)	1.1 mg/l (1)		
Pentachlorophenol	Semi-Volatile					20 ug/l (4)	13 ug/l (4)	1.01 mg/l	
Phthalate Esters	Semi-Volatile					940 ug/l (1)	3 ug/l (1)		
Simazine	Semi-Volatile								

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU5, WOMAN CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Toluene	Semi-Volatile	1 mg/l		1 mg/l		17.5 mg/l (1)		14.3 mg/l	424 mg/l
Toxaphene	Semi-Volatile		3 ug/l			0.73 ug/l	0.2 ng/l	0.71 ng/l	0.73 ng/l
Vinyl Chloride	Semi-Volatile	2 ug/l		0 ug/l			970 ug/l (1)	2 ug/l**	525 ug/l**

EXPLANATION OF TABLE

* = secondary maximum contaminant level
** = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10-5 risk level.

AWQC = Ambient Water Quality Criteria
CWA = Clean Water Act
SDWA = Safe Drinking Water Act
SS = species specific

(1) criteria not developed; value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7.8 pH used)

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR PArts 141, 142 and 143, Final Rule, effective July 30, 1992
(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE
STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C Fish &	Table D Radio-	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcin-ogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	(2)	Water Ingestion	nuclide Standards	Acute Value	Chronic Value	Woman Ck	Walnut Ck
Dissolved Oxygen	Field Parameter				5.0 mg/l	5.0 mg/l	3.0 mg/l				5.0 mg/l	5.0 mg/l		
pH	Field Parameter				6.5-9.0	6.5-9.0					6.5-9	6.5-9		
Specific Conductance	Field Parameter													
Temperature	Field Parameter				30 degrees	30 degrees								
Total Dissolved Solids	Indicator													
Bicarbonate	Anion													
Carbonate	Anion													
Chloride	Anion										3 ug/l	3 ug/l		
Fluoride	Anion													
N as Nitrate	Anion						100 mg/l				10 mg/l	10 mg/l		
N as Nitrate+Nitrite	Anion													
N as Nitrite	Anion				SS	SS	10 mg/l				1 mg/l	1 mg/l		
Potassium	Anion													
Sulfate	Anion										250 mg/l	250 mg/l		
Aluminum	Metal				950 ug/l	150 ug/l								
Antimony	Metal													
Arsenic	Metal				360 ug/l	150 ug/l	100 ug/l				50 ug/l			
Arsenic III	Metal													
Arsenic V	Metal													
Barium	Metal													
Beryllium	Metal						100 ug/l							
Cadmium	Metal				TVS	TVS	10 ug/l				TVS	TVS		
Calcium	Metal													
Chromium	Metal													
Chromium III	Metal				TVS	TVS	100 ug/l				50 ug/l			
Chromium VI	Metal				16 ug/l	11 ug/l	100 ug/l				TVS	TVS		
Cobalt	Metal													
Copper	Metal				TVS	TVS	200 ug/l				TVS	TVS		
Cyanide	Metal				5 ug/l	5 ug/l	200 ug/l				5 ug/l	5 ug/l		

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE
STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C Fish &	Table D Radio-	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcinogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	(2)	Water Ingestion	nuclide Standards	Acute Value	Chronic Value	Woman Ck	Walnut Ck
Iron	Metal					1 mg/l						300 ug/l (5)		
Lead	Metal				TVS	TVS	100 ug/l				TVS	TVS		
Magnesium	Metal													
Manganese	Metal					1 mg/l	200 ug/l					50 ug/l (5)		
Mercury	Metal				2.4 ug/l	0.1 ug/l						10 ng/l		
Molybdenum	Metal													
Nickel	Metal				TVS	TVS	200 ug/l				TVS	TVS		
Selenium	Metal				135 ug/l	17 ug/l	20 ug/l				10 ug/l			
Silver	Metal				TVS	TVS					TVS	TVS		
Sodium	Metal													
Thallium	Metal					15 ug/l								
Tin	Metal													
Titanium	Metal													
Tungsten	Metal													
Vanadium	Metal													
Zinc	Metal				TVS	TVS	2.0 mg/l				TVS	TVS		
Americium	Radionuclide												0.05 pCi/l	0.05 pCi/l
Americium 241	Radionuclide									30 pCi/l				
Cesium 137	Radionuclide													
Cesium 134	Radionuclide									80 pCi/l			80 pCi/l	80 pCi/l
Gross Alpha	Radionuclide												7 pCi/l	11 pCi/l
Gross Beta	Radionuclide												5 pCi/l	19 pCi/l
Plutonium	Radionuclide												0.05 pCi/l	0.05 pCi/l
Plutonium 238+239+240	Radionuclide									15 pCi/l				
Radium 226+228	Radionuclide									5 pCi/l				
Strontium 90	Radionuclide									8 pCi/l			8 pCi/l	8 pCi/l
Thorium 230+232	Radionuclide									60 pCi/l				
Tritium	Radionuclide									20,000 pCi/l			500 pCi/l	500 pCi/l
Uranium 233+234	Radionuclide													

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE
STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C Fish &	Table D Radio-	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcin-ogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	(2)	Water Ingestion	nuclide Standards	Acute Value	Chronic Value	Woman Ck	Walnut Ck
Uranium 235	Radionuclide													
Uranium 238	Radionuclide													
Uranium (total)	Radionuclide									40 pCi/l			5 pCi/l	10 pCi/l
1,1-Dichloroethane	Volatile													
1,1-Dichloroethene	Volatile	7 ug/l						7 ug/l						
1,1,1-Trichloroethane	Volatile	200 ug/l						200 ug/l						
1,1,2,2-Tetrachloroethane	Volatile			2.4 mg/l					170 ng/l			170 ng/l		
1,1,2-Trichloroethane	Volatile	28 ug/l (6)		9.4 mg/l				28 ug/l (6)	600 ng/l			600 ng/l		
1,2-Dichloroethane	Volatile	5 ug/l	118 mg/l	20 mg/l				5 ug/l						
1,2-Dichloroethene	Volatile	70 ug/l						70 ug/l						
1,2-Dichloropropane	Volatile	560 ng/l	23 mg/l	5.7 mg/l				560 ng/l						
2-Butanone	Volatile													
2-Hexanone	Volatile													
4-Methyl-2-pentanone	Volatile													
Acetone	Volatile													
Benzene	Volatile	5 ug/l						5 ug/l						
Benzo(a)anthracene	Volatile													
Benzo(a)pyrene	Volatile													
Benzo(b)fluoranthene	Volatile													
Benzo(g,h,i)perylene	Volatile													
Benzo(k)fluoranthene	Volatile													
Bromodichloromethane	Volatile													
Bromoform	Volatile													
Bromomethane	Volatile													
Chlorinated Benzenes	Volatile													
Chlorobenzene	Volatile	300 ug/l						300 ug/l						
Chloroethane	Volatile													
Chloroform	Volatile	Tot THM <100 ug/l (4)	28.9 mg/l	1.24 mg/l				Tot THM <100 ug/l (4)	0.19 ug/l			0.19 ug/l		

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C Fish &	Table D Radio-	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcinogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	(2)	Water Ingestion	nuclide Standards	Acute Value	Chronic Value	Woman Ck.	Walnut Ck
Chloromethane	Volatile													
cis-1,3-Dichloropropene	Volatile													
Dibromochloromethane	Volatile													
Ethyl Benzene	Volatile	680 ug/l	32 mg/l					680 ug/l						
Fluoranthene	Volatile		3.98 mg/l											
Haloethers	Volatile													
Halomethanes	Volatile								190 ng/l			190 ng/l		
Indeno(1,2,3-cd)pyrene	Volatile													
Methylene Chloride	Volatile													
Phenanthrene	Volatile													
Phenol	Volatile													
Polynuclear Aromatic Hydrocarbons	Volatile								2.8 ng/l			2.8 ng/l		
Pyrene	Volatile													
Styrene	Volatile													
Tetrachloroethanes	Volatile													
Tetrachloroethene	Volatile	10 ug/l	5.28 mg/l	840 ug/l				10 ug/l	800 ng/l					
Total Xylenes	Volatile													
trans-1,3-Dichloropropene	Volatile													
Trichloroethanes	Volatile													
Trichloroethene	Volatile	5 ug/l	45 mg/l	21.9 mg/l				5 ug/l						
Vinyl Acetate	Volatile													
1,2-Dichlorobenzene	Semi-Volatile	620 ug/l						620 ug/l						
1,3-Dichlorobenzene	Semi-Volatile	620 ug/l						620 ug/l						
1,4-Dichlorobenzene	Semi-Volatile	75 ug/l						75 ug/l						
1,2,4-Trichlorobenzene	Semi-Volatile													
2-Chloronaphthalene	Semi-Volatile													
2-Chlorophenol	Semi-Volatile													
2-Methylnaphthalene	Semi-Volatile													

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C Fish &	Table D Radio-	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcin-ogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	(2)	Water Ingestion	nuclide Standards	Acute Value	Chronic Value	Woman Ck	Walnut Ck
2-Methylphenol	Semi-Volatile													
2-Nitroaniline	Semi-Volatile													
2-Nitrophenol	Semi-Volatile													
2,4-Dichlorophenol	Semi-Volatile	21 ug/l	2.02 mg/l	365 ug/l				21 ug/l						
2,4-Dimethylphenol	Semi-Volatile													
2,4-Dinitrophenol	Semi-Volatile													
2,4-Dinitrotoluene	Semi-Volatile													
2,4,5-Trichlorophenol	Semi-Volatile	700 ug/l (6)						700 ug/l (6)						
2,4,6-Trichlorophenol	Semi-Volatile	2.0 ug/l (6)		970 ug/l				2.0 ug/l (6)	1.2 ug/l			1.2 ug/l		
3-Nitroaniline	Semi-Volatile													
3,3-Dichlorobenzidine	Semi-Volatile								10 ng/l					
4-Bromophenyl Phenylether	Semi-Volatile													
4-Chloroaniline	Semi-Volatile													
4-Chlorophenyl Phenyl Ether	Semi-Volatile													
4-Chloro-3-methylphenol	Semi-Volatile													
4-Methylphenol	Semi-Volatile													
4-Nitroaniline	Semi-Volatile													
4-Nitrophenol	Semi-Volatile													
4,6-Dinitro-2-methylphenol	Semi-Volatile													
Acenaphthene	Semi-Volatile		1.7 mg/l	520 ug/l										
Acetone	Semi-Volatile													
Acrylonitrile	Semi-Volatile		7.55 mg/l	2.6 mg/l					58 mg/l			58 mg/l		
Aldrin	Semi-Volatile	2 ng/l	3 ug/l					2 ng/l	74 pg/l			74 pg/l		
Anthracene	Semi-Volatile													
Atrazine	Semi-Volatile											3 ug/l		
Benzidine	Semi-Volatile	0.2 ng/l	2.5 mg/l					0.2 ng/l	0.12 ng/l			0.12 ng/l		
Benzoic Acid	Semi-Volatile													
Benzyl Alcohol	Semi-Volatile													
bis(2-Chloroethoxy)methane	Semi-Volatile													
bis(2-Chloroethyl)ether	Semi-Volatile	30 ng/l (6)						30 ng/l (6)				0.0037 ng/l		

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE
STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C Fish &	Table D Radio-	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcinogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	(2)	Water Ingestion	nuclide Standards	Acute Value	Chronic Value	Woman Ck.	Walnut Ck
bis(2-Chloroisopropyl)ether	Semi-Volatile													
bis(2-Ethylhexyl)phthalate	Semi-Volatile													
Butyl Benzylphthalate	Semi-Volatile													
Carbon Disulfide	Semi-Volatile													
Carbon Tetrachloride	Semi-Volatile	5 ug/l	35.2 mg/l					5 ug/l						
Chlorinated Benzenes	Semi-Volatile													
Chlorinated Ethers	Semi-Volatile													
Chlorinated Napthalenes	Semi-Volatile													
Chloroalkylethers	Semi-Volatile													
Chlorodane	Semi-Volatile	30 ng/l	2.4 ng/l	4.3 ng/l				0.03 ug/l	0.46 ng/l			0.46 ng/l		
Chlorophenol	Semi-Volatile													
DDT	Semi-Volatile	0.1 ug/l	1.1 ug/l	1.0 ng/l				0.1 ug/l	24 pg/l			24 pg/l		
DDE	Semi-Volatile		1.05 mg/l											
DDD	Semi-Volatile		0.6 ug/l											
Dichlorobenzidine	Semi-Volatile											0.01 ug/l		
Dibenzofuran	Semi-Volatile													
Dibenz(a,h)anthracene	Semi-Volatile													
Dichlorobenzenes	Semi-Volatile													
Dichloroethenes	Semi-Volatile													
Dichloromethane	Semi-Volatile													
Dieldrin	Semi-Volatile	2 ng/l	2.5 ug/l	1.9 ng/l				2 ng/l	71 pg/l			71 pg/l		
Diethylphthalate	Semi-Volatile													
Dimethylphthalate	Semi-Volatile													
Di-n-butylphthalate	Semi-Volatile													
Dinitrotoluene	Semi-Volatile													
Di-n-octylphthalate	Semi-Volatile													
Dioxin	Semi-Volatile	0.22 pg/l	0.01 ug/l	0.01 ng/l				0.22 pg/l	13 fg/l			13 fg/l		
Endosulfan I	Semi-Volatile		0.22 ug/l	0.056 ug/l										
Endosulfan II	Semi-Volatile													
Endosulfan Sulfate	Semi-Volatile													

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C Fish &	Table D Radio-	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcin-ogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	(2)	Water Ingestion	nuclide Standards	Acute Value	Chronic Value	Woman Ck	Walnut Ck
Endrin	Semi-Volatile	0.2 ug/l	0.18 ug/l	2.3 ng/l				0.2 ug/l						
Endrin Ketone	Semi-Volatile													
Fluorene	Semi-Volatile													
Halomethanes	Semi-Volatile	100 ug/l						0.1 mg/l	0.19 ug/l			0.19 ug/l		
Heptachlor	Semi-Volatile	8 ng/l	0.52 ug/l	3.8 ng/l				8 ng/l	0.28 ng/l			0.28 ng/l		
Heptachlor Epoxide	Semi-Volatile	4 ng/l						4 ng/l						
Hexachlorobenzene	Semi-Volatile	0.02 ug/l						0.02 ug/l	0.72 ng/l			0.72 ng/l		
Hexachlorobutadiene	Semi-Volatile	14 ug/l (6)	90 ug/l	9.3 ug/l				14 ug/l	0.45 ng/l			0.45 ng/l		
Hexachlorocyclohexane, Alpha	Semi-Volatile								9.2 ng/l			9.2 ng/l		
Hexachlorocyclohexane, Beta	Semi-Volatile								16.3 ng/l			16.3 ng/l		
Hexachlorocyclohexane, (Lindane) Gamma	Semi-Volatile	4 ug/l	2.0 ug/l	80 ng/l				4 ug/l	18.6 ng/l			18.6 ng/l		
Hexachlorocyclohexane, Technical	Semi-Volatile											12.3 ng/l		
Hexachlcrocyclopentadiene	Semi-Volatile	49 ug/l (6)	7 ug/l	5.2 ug/l				49 ug/l						
Hexachloroethane	Semi-Volatile		0.98 ug/l	0.54 ug/l					1.9 ug/l			1.9 ug/l		
Isophorone	Semi-Volatile	1.05 mg/l (6)	117 mg/l					1.05 mg/l						
Methoxychlor	Semi-Volatile	100 ug/l		0.03 ug/l				0.1 mg/l						
Naphthalene	Semi-Volatile		2.3 mg/l	620 ug/l										
Nitrobenzene	Semi-Volatile	3.5 ug/l (6)	27 mg/l					3.5 ug/l						
Nitrophenols	Semi-Volatile													
Nitrosamines	Semi-Volatile													
Nitrosodibutylamine	Semi-Volatile								6.4 ng/l			6.4 ng/l		
Nitrosodiethylamine	Semi-Volatile								0.8 ng/l			0.8 ng/l		
Nitrosodimethylamine	Semi-Volatile								1.4 ng/l			1.4 ng/l		
Nitrosoplyrrolidine	Semi-Volatile								16 ng/l			16 ng/l		
N-Nitrosodiphenylamine	Semi-Volatile								4.9 ug/l			4.9 ug/l		
N-Nitroso-di-n-dipropylamine	Semi-Volatile													
PCBs	Semi-Volatile	5 ng/l	2.0 ug/l	14 ng/l				5 ng/l	79 pg/l			79 pg/l		
Pentachlorinated Ethanes	Semi-Volatile													
Pentachlorophenol	Semi-Volatile	200 ug/l	9 ug/l	5.7 ug/l				200 ug/l						
Phthalate Esters	Semi-Volatile													

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, WOMAN CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide Standards	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Noncarcin-ogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)				Acute Value	Chronic Value	Woman Ck	Walnut Ck
Simazine	Semi-Volatile											4 ug/l		
Toluene	Semi-Volatile	2.42 mg/l	17.5 mg/l					2.42 mg/l						
Toxaphene	Semi-Volatile	5 ug/l		0.73 ug/l	0.2 ng/l			5 ug/l						
Vinyl Chloride	Semi-Volatile	2 ug/l						2 ug/l						

EXPLANATION OF TABLE

CDH = Colorado Department of Health
SS = species specific
TVS = Table Value Standard (hardness dependent), see Table III in (a)
WQCC = Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.
(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(5) Lowest value given: dissolved or total recoverable
(6) Based on 10E-6 cancer risk from EPA Integrated Risk Information System
(7) Segment 4 standards are ARARs and Segment 5 standards are goals (TBCs)
(8) Includes Table 1: Additional Organic Chemical Standards (chronic only)

(a) CDH/WQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 9/30/1989 (Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/WQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990

facility siting laws, that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate." The most stringent promulgated standards are applied as ARAR (Preamble to NCP, 55 FR 8741).

3.2.2 TBCs

In addition to applicable or relevant and appropriate requirements, advisories, criteria, or guidance may be identified as TBC for a particular release. As defined in 40 CFR 300.400(g)(3), the TBC category consists of advisories, criteria, or guidance developed by EPA, other federal agencies, or states that may be useful in developing remedies. Use of TBCs is discretionary rather than mandatory, as is the case with ARARs.

3.2.3 ARAR Categories

In general, there are three categories of ARARs:

1. Ambient or chemical-specific requirements

2. Location-specific requirements

3. Performance, design, or other action-specific requirements

ARARs are generally considered to be dynamic in nature in that they evolve from general to very specific in the CERCLA site cleanup process. Initially, during the RI work plan stage, probable chemical-specific ARARs may be identified, usually based on a limited amount of data. Chemical-specific ARARs at this point have meaning only in that they may be used to ensure that appropriate detection limits have been established so that data collected in the RI will be amenable for comparison to ARAR standards. It is also appropriate to identify location-specific ARARs early in the RI process so that information may be gathered to determine if restrictions may be placed on the concentration of hazardous substances or on the conduct of an activity solely because it occurs in a special location.

Chemical-specific ARARs do not currently exist for soils. As the remedial investigation proceeds, information will become available from the risk assessment which will allow a determination of acceptable contaminant concentrations in soils to ensure environmental "protectiveness."

3.2.4 Feasibility Study ARAR Requirements

Development of a preliminary list of potential chemical-specific ARARs in the RI process also allows the establishment of a list of preliminary remediation goals in the early FS process, which is essentially a tentative listing of contaminants together with initially anticipated cleanup concentrations or risk levels for each medium. Preliminary remediation goals serve to focus the development of alternatives on remedial technologies that can achieve the remediation goals, thereby limiting the number of alternatives to be considered in the detailed remedial alternative analysis, conducted later in the FS process. As more information becomes available during the RI stage, chemical-specific ARARS may become more refined as constituents are added or deleted, which is often the case when the RI takes place in numerous phases. When data collection is complete, revised chemical-specific ARAR selection may be proposed.

When the data collection is complete, it is also appropriate to refine location-specific ARARs which may affect the development of remedial alternatives. During development of remedial action alternatives at the beginning of the FS process, a preliminary consideration of action-specific ARARs will be conducted. As remedial alternatives are screened during the FS, action-specific ARARs will be identified. When a detailed analysis of the remedial alternatives is conducted, all action-specific ARARs are refined and finalized with respect to each alternative before a comparison of alternatives begins. At this point, a discussion is provided in the FS report for each remedial alternative regarding the rationale for all ARAR determinations.

3.2.5 Remedial Action

CERCLA §121 specifically requires attainment of all ARARs. Moreover, as explained in the preamble to the National Contingency Plan (NCP) (55 FR 8741), in order to attain all ARARs, a remedial action must comply with the most stringent requirement, which then ensures attainment of all other ARARs. Furthermore, CERCLA requires that the remedies selected attain ARARs and be protective of human health and the environment. Consequently, preliminary remediation goals based on ARARs will require modification as new information and data are collected in the RI, including the baseline risk assessment (to be conducted), when ARARs are not available or are determined to be inadequate for protection of human health and the environment.

3.2.6 Remediation Goals

Development of remediation goals is actually a portion of the overall development of remedial action objectives, which ultimately will define the required endpoint of the selected remedial action. As stated in the preamble to the NCP (55 FR 8713), "remedial action objectives are the more general description of what the remedial action will accomplish. Remediation goals are a subset of remedial action objectives and consist of medium-specific or operable unit-specific chemical concentrations that are protective of human health and the environment and serve as goals for the remedial action. The remedial action objectives ... should specify: (1) the contaminants of concern, (2) exposure routes and receptors, and (3) an acceptable contaminant level or range of levels for each exposure medium (i.e., preliminary remediation goals)." According to 40 CFR 300.430 (e)(2)(i), "Remediation goals shall establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following:

- ARARs (chemical-specific) and
  - Acceptable exposure levels for systemic toxicants
  - Acceptable exposure levels for known or suspected carcinogens
  - Technical limitations (e.g., detection limits)
  - Uncertainty factors
  - Other pertinent information
- Maximum Contaminant Level Goals (MCLGs) (or Maximum Contaminant Levels -- MCLs -- where MCLGs are zero or where MCLGs are not relevant and appropriate), where relevant and appropriate
- Acceptable exposure levels where multiple contaminants or multiple exposure pathways will cause exposure at ARAR levels will result in cumulative risk in excess of 10^{-4}
- Clean Water Act (CWA) Water Quality Criteria, where relevant and appropriate
- A CERCLA Alternative Concentration Limit (ACL) established pursuant to CERCLA § 121(d)(2)(B)(ii)
- Environmental evaluations, performed to assess specific threats to the environment

When a remedial action alternative is formally selected, all chemical-, location-, and action-specific ARARs have also been defined in final form. If it is found that the most suitable remedial alternative does not meet an ARAR, the NCP, at 40 CFR 300.430 (f)(1)(ii)(C), provides for waivers of ARARs under certain circumstances, such as technical impracticability, risk, or inconsistent application of state requirements. From this point, the alternative will become the final remedy as it is incorporated into the Record of Decision (ROD). When the final ROD has been signed, requirements may be modified only when they are determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment (40 CFR 300.430(f)(1)(ii)).

4.0
DATA NEEDS AND DATA QUALITY OBJECTIVES

The primary objective of a RCRA Facility Investigation (RFI)/Remedial Investigation (RI) is to collect the data necessary to determine the nature, distribution, and migration pathways of contaminants. This information is used to support a baseline risk assessment and environmental assessment. These assessments determine the need for remediation and are used to evaluate remedial alternatives. Five general goals of an RFI/RI (U.S. EPA 1988a) are to

- Characterize site physical features
- Define contaminant sources
- Determine the nature and extent of contamination
- Describe contaminant fate and transport
- Provide a baseline risk assessment

Data quality objectives (DQOs) are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI (U.S. EPA 1987a). The DQO process is divided into three stages:

- Stage 1 - Identify decision types
- Stage 2 - Identify data uses/needs
- Stage 3 - Design data collection program

Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving those goals. This section of the RFI/RI work plan proceeds through the DQO process.

4.1 STAGE 1 - IDENTIFY DECISION TYPES

4.1.1 Identify and Involve Data Users

Data users are the decision makers and the primary and secondary data users. The decision makers for OU5 are the management and regulatory personnel for EG&G, the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH). EG&G's contractor will provide day-to-day management of the RI in accordance with this work plan. The decision makers have been and are involved in the OU5 DQO process through the Interagency Agreement (IAG), which specifies the minimum level of effort for the Phase I RI. The decision makers remain involved through the review and approval process specified in the IAG.

Primary data users are those individuals involved in ongoing RI activities. These are EG&G and EG&G's contractor technical staff. They will be involved in the collection and analysis of the data and in the preparation of the RI Report, including the Baseline Risk Assessment and the Environmental Assessment.

Secondary data users are those users who rely on RI outputs to support their activities. Secondary data users may include EG&G personnel working on other operable units or sitewide projects, EPA and CDH.

4.1.2 Evaluate Available Data

The historical and current conditions of each site are described in Section 2.0 of this work plan.

The following is a summary of the existing information based on the data presented in Section 2.0.

- Only a portion of the data collected to date have been validated and there are some uncertainties in the unvalidated data.

- Contamination by radioactive materials is known or suspected to exist at the Original Landfill (IHSS 115), Ash Pits (IHSS 13), and C-Series Ponds (IHSS 142). Contamination may also exist in Woman Creek and the South Interceptor Ditch.

- Metals contamination may also exist in these IHSSs, as well as in Woman Creek and the South Interceptor Ditch.

- Contamination, if any, due to other substances is unknown at this time.

- The extent of contamination, if any, at the IHSSs in OU5 is unknown at this time.

- The presence of contamination is uncertain in the Surface Disturbance areas. Investigations should focus on confirmation of the presence or absence of contamination.

- There appears to be a potential for contamination from topographically or hydraulically upgradient sources (i.e., other operable units) to be present at the IHSSs.

4.1.3 Develop Conceptual Models

Conceptual models have been developed for each IHSS in subsection 2.6. These models include a description of potential sources, pathways and receptors. Since very few previous studies have been conducted, the models are basic Phase I models. It is not known if the sources or pathways actually exist at the IHSSs. Figure 4-1 presents a schematic Phase I conceptual model for IHSS 115 - Original Landfill. Models for the other IHSSs in the Woman Creek drainage are similar.

4.1.4 Specify Phase I RFI/RI Objectives and Data Needs

Based on existing data and the IHSS conceptual models, site-specific Phase I RFI/RI objectives/data needs associated with identifying contaminant sources and the nature and extent of contamination are shown in Table 4-1.

The objectives of the Phase I RFI/RI are:

- To characterize the physical and hydrogeologic setting of the IHSSs
- To assess the presence or absence of contamination at each site
- To characterize the nature and extent of contamination at the sites, if present
- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs.

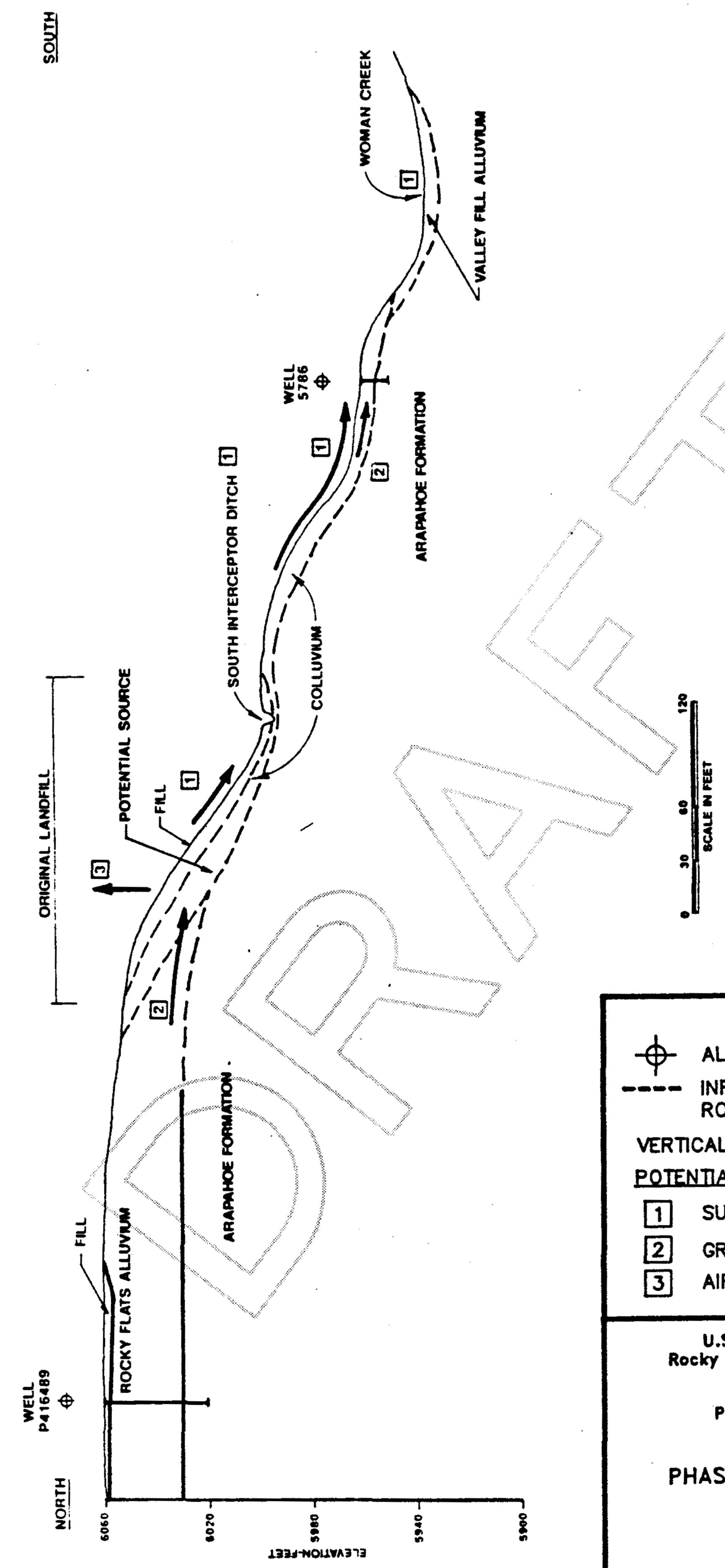
4.2 STAGE 2 - IDENTIFY DATA USES/NEEDS

Stage 2 of the DQO process defines data uses and specifies the types of data needed to meet the project objectives. The summary of Stage 2 of the DQO process is presented as Table 4-1.

4.2.1 Identify Data Uses

RI/FS data uses can be described in general purpose categories:

- Site characterization
- Health and safety
- Risk assessment
- Evaluation of alternatives
- Engineering design of alternatives
- Monitoring during remedial action
- PRP determination



EXPLANATION

⊕ ALLUVIAL MONITORING WELL

---- INFERRED BOUNDARY OF ROCK UNITS

VERTICAL EXAGGERATION 1.5X

POTENTIAL PATHWAYS

1 SURFACE WATER

2 GROUNDWATER

3 AIR

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

PHASE 1 CONCEPTUAL MODEL
ORIGINAL LANDFILL

FIGURE 4-1 MARCH 1991

TABLE 4-1

DATA QUALITY OBJECTIVES

Data Need	Sample/Analysis Method	Analytical Level[1]	Data Use
CHARACTERIZE PHYSICAL FEATURES			
• Identify extent of the Landfill, Ash Pits, and surface disturbance areas	• Review aerial photographs • Visual inspection • Logging of boreholes	I & II	• Site Characterization • Alternatives Evaluation
• Characterize surface water and sediments in the ponds	• Logging of sediment samples • Measurement of field parameters in water in the ponds	I & II	• Site Characterization • Alternatives Evaluation
• Characterize depressions made at the surface disturbances	• Review aerial photographs • Visual inspection • Logging of samples collected	I & II	• Site Characterization • Alternatives Evaluation
CHARACTERIZE AND DELINEATE CONTAMINANT SOURCES			
• Identify plumes (if present) at the Landfill	• Soil gas survey • Boreholes and wells with analytical testing on samples, if plumes are identified	II (field GC) IV (analytical)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Identify source of pipes in Landfill	• Sewer snake survey and sampling with analytical testing	I (field) IV (analytical)	• Site Characterization
• Characterize sources (if present) at the Ash Pit areas	• Boreholes and surface samples in areas of pits and pads with analytical testing of samples	I & II (field) IV (analytical)	• Site Characterization • Alternatives Evaluation • Risk Assessment

TABLE 4-1
DATA QUALITY OBJECTIVES
(Concluded)

Data Need	Sample/Analysis Method	Analytical Level[1]	Data Use
CHARACTERIZE NATURE AND EXTENT OF CONTAMINATION			
• Characterize plumes or hotspots identified at the Landfill	• Boreholes and wells with analytical testing of samples, if plumes are identified	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize horizontal and vertical extent and nature of contamination at the Ash Pits	• Boreholes and wells with analytical testing of samples	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize extent of radiation at Landfill, Ash Pits and surface disturbances	• Radiation surveys	I & II	• Site Characterization • Health and Safety
• Characterize nature and extent of contamination in surface water and sediments in Woman Creek and the South Interceptor Ditch	• Sediment and surface water sampling with analytical testing of the samples	II (field) IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize nature and extent of contamination in alluvial groundwater	• Install and sample wells	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Assess the potential for contamination at surface disturbance areas	• Surface samples with analytical testing	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment

Note: [1] Analytical levels are described in Table 4-2.

Since this work plan describes a Phase I RI, data uses such as engineering design and monitoring during remediation (both remedial action activities) will not be considered. The data use for PRP determination is also not appropriate to this work plan. The remaining four data uses will be important in meeting the objectives identified in subsection 4.1.4.

4.2.2 Identify Data Types

Data types can be specified in broad groups initially and then divided into more specific components. For the Phase I investigation, soil, sediment, groundwater and surface water samples will be collected. In addition, radiation surveys will be conducted over most of the units. These data types will provide broad Phase I information regarding the presence or absence of contamination at the units. Selection of chemical analyses and physical testing will be based on the objectives of the Phase I program and on the past activities at the units. Data types are listed in Table 4-1 as sample/analysis methods.

4.2.3 Identify Data Quality Needs

EPA defines five levels of analytical data as follows (U.S. EPA 1987a):

- Level I - field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative but results are available in real-time. It is the least costly of the analytical options.

- Level II - field analyses using more sophisticated portable analytical instruments: in some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. The quality depends on the use of suitable calibration standards, reference materials, and sample preparation equipment; and the training of the operator. Results are available in real-time or several hours.

- Level III - all analyses performed in an off-site analytical laboratory. Level III analyses may or may not use Contract Laboratory Program (CLP) procedures, but do not usually utilize the validation or documentation procedures required of CLP Level IV analysis. The laboratory may or may not be a CLP laboratory.

- Level IV - CLP routine analytical services (RAS). All analyses are performed in an off-site CLP analytical laboratory following CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

- Level V - analysis by non-standard methods. All analyses are performed in an off-site analytical laboratory which may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits. CLP special analytical services (SAS) are Level V.

The levels appropriate to the data need and data use have been specified in Table 4-1 for each data need. The levels as they apply to this work plan and specific analyses are presented in Table 4-2.

4.2.4 Identify Data Quantity Needs

Data quantity needs are based primarily on the quantities specified in the IAG. The Phase I data will be evaluated to determine the appropriate number of samples to be obtained in subsequent phases of the RI.

4.2.5 Evaluate Sampling/Analysis Options

The sampling/analysis approach for this Phase I work plan is based on a stepped, or phased approach. Screening level sampling and analysis is followed by sampling of hotspots or other areas identified during screening. Where no data are available, a grid system will be used.

4.2.6 Review PARCC Parameter Information

PARCC (precision, accuracy, representativeness, completeness and comparability) parameters are indicators of data quality. Precision, accuracy and completeness goals are established for this work plan based on the analyses being performed and the analytical levels. PARCC goals are specified in the Quality Assurance Addendum (QAA) in Section 10.0 of this work plan.

4.3 STAGE 3 - DESIGN DATA COLLECTION PROGRAM

The purpose of Stage 3 of the DQO process is to design the specific data program for the Phase I Woman Creek drainage RI. To accomplish this, the elements identified in Stages 1 and 2 and the IAG are assembled, and the Sampling and Analysis Plan (SAP) is prepared. The SAP consists of a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPjP). These two components are addressed in Sections 7.0 and 10.0 of this work plan.

TABLE 4-2

LEVEL OF ANALYSIS

Required Analytical Level	Task
Level I (Field Screens)	• Water level measurement • pH measurement • Screening for organics (OVA/HNu) • Screening for radionuclides (beta-gamma) • Temperature • Specific conductance • Screening for buried objects (magnetometer, pipe locator)
Level II (Field Analyses)	• Screening for organics (GC) • Screening for radionuclides (gross beta/gross alpha, gamma spec) • Analysis of engineering properties
Level III (Laboratory Analyses using EPA Standard Methods)	• Major ion analysis • Organics analysis • Inorganics analysis
Level IV (Laboratory Analyses using EPA CLP Methods)	• Analysis of Target Compound List (TCL) and Target Analyte List (TAL)
Level V (Nonstandard Analyses)	• Radiological analyses • Chemical analyses requiring modification of standard methods • Special Analytical Services (SAS)

Source: U.S. EPA (1987)

5.1 TASK 1 - PROJECT PLANNING

Project planning will consist of the activities necessary to initiate the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Individual Hazardous Substance Sites (IHSSs) in the Woman Creek drainage. Activities undertaken for this project have included a review of previous investigations, historical aerial photographs, and other historical information. Results of this review are presented in Section 2.0 of this work plan. Prior to field investigations, it is necessary to complete the review of the existing data, including plant records and plans, available aerial photographs, and new data which become available after preparation of this work plan. The Interagency Agreement (IAG) also requires the submittal of several existing reports to the regulatory agencies. These reports will be assembled and reviewed during the project planning task.

Available aerial photographs will be reviewed again to assess the types and extent of activities at several of the IHSSs. A discussion of the aerial photograph review for each unit is included as the Step 1 work for each unit in Section 7.0 of this document. Available reports and plant plans will also be reviewed again. The findings of the aerial photo review and the records review will be used to finalize the field investigation program.

There are ongoing site studies at Rocky Flats of surface water and sediments, groundwater, geology (EG&G 1990b), background geochemistry (EG&G 1990c), and ambient air that may provide data that have bearing on the investigations in Woman Creek. These data will be compiled and evaluated during Task 1. For example, the need for additional surface water and sediment sampling locations will be dependent on the locations of ongoing sampling and the scope of analyses. If available data from ongoing investigations meet the requirements of the Phase I sampling and analysis plan, the samples proposed in Section 7.0 need not be collected again.

Other project-related documents are currently being prepared. The Sampling and Analysis Plan (SAP), which includes the site-wide Quality Assurance Project Plan (QAPjP) and Standard Operating Procedures (SOP) for field activities, is currently being completed by EG&G. The Health and Safety Plan (HSP) is also being completed by EG&G. The Field Sampling Plan (FSP) is included as Section 7.0 of this document. The Phase I FSP will be revised as necessary based on the findings of the photo and records review.

5.2 TASK 2 - COMMUNITY RELATIONS

The information contained in this section is summarized from DOE (1990b). In accordance with the IAG, dated January 22, 1991, the Communications Department at Rocky Flats is developing a plant-wide Community Relations Plan (CRP) to develop an interactive relationship with the public relating to environmental restoration activities. A Draft Community Relations Survey Plan has been completed and forwarded to the Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the public for review. This plan specifies activities planned to complete the Environmental Restoration (ER) Program CRP, including plans for community interviews. The draft CRP was completed in September and the final CRP in November 1990, in accordance with the IAG schedules. Accordingly, a site-specific CRP is not required for Operable Unit Number 5 (OU5). The ER program community relations activities include participation by plant representatives in informational workshops, meetings of the Rocky Flats Environmental Monitoring Council, briefings of the public on proposed remedial action plans, and meetings to solicit public comment on various ER program plans and actions.

The Communications Department is continuing other public information efforts to keep the public informed on ER activities and other issues related to plant operations. A Speakers Bureau program sends speakers to civic groups and educational organizations, while a public tour program allows the public to visit Rocky Flats. An Outreach Program is also in place in which plant officials visit elected officials, the news media, and business and civic organizations to further discuss issues related to Rocky Flats and ER activities. The Communications Department receives numerous public inquiries which are answered through telephone conversations or by sending written informational materials to the requestor.

5.3 TASK 3 - FIELD INVESTIGATION

Phase I field investigations will be conducted at the IHSSs in Woman Creek to collect samples and data concerning the nature and extent of contamination, if any, at each unit. The data and sample results will be used to support the Phase I Environmental Evaluation and Phase I Baseline Risk Assessment, as well as meet the objectives and data needs described in Section 4.0 of this work plan. It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs prior to Feasibility Studies.

Three types of activities will be performed during the Phase I field investigation: screening activities, sampling activities, and monitoring well installation. Screening activities include visual inspections, radiological surveys, and soil gas surveys. Sampling activities include surface soil sampling, subsurface sampling using test borings, surface water sampling, and sediment sampling. Monitoring wells will be installed and sampled at specified locations and in some test borings.

Ten IHSSs have been included in OU5 in the Woman Creek drainage. These IHSSs have been grouped into four groups based on the historical use of the units and the physical similarities of the units. Because of the diverse nature of the IHSS groups, the Phase I field investigations for each group will be different. The general discussion of field activities planned for each IHSS group, based on the IAG, is given below. Specific field activities are described in the Phase I FSP in Section 7.0 of this work plan.

5.3.1 IHSS 115 - Original Landfill

Screening activities at the Original Landfill will consist of a review of the gamma radiation survey recently completed and completion of a soil gas survey. Sampling will include subsurface sampling in borings and sediment and surface water sampling adjacent to the unit. Wells will be installed and sampled downgradient of the unit and in selected soil borings if a plume is encountered. An additional activity at the unit will be a study of the pipes protruding from the landfill and sampling of effluent from the pipes, if present.

5.3.2 IHSS 133.1-6 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad

A radiological survey will be the screening activity conducted at the IHSS 133 sites. Surface soil samples will be collected from the locations that have high radiation concentrations identified during the radiological survey. Subsurface samples will also be collected from borings in the IHSS 133 areas. Three monitoring wells will be installed downgradient of the units and sampled.

5.3.3 IHSS 142 - Detention Ponds - C-Series

There will not be any screening activities at the two C-Series ponds. Surface water samples will be collected from several locations in each pond. Sediment samples will be collected in the ponds, as well as along the entire Woman Creek drainage within the Rocky Flats Plant. Sediment samples will also be collected in the South Interceptor Ditch (SID). Background surface water and sediment samples will be collected west of the plant. Two monitoring wells will be installed and sampled in the alluvium downgradient of each of the dams at Ponds C-1 and C-2.

5.3.4 IHSS 209 - Surface Disturbance Southeast of Building 881 and Surface Disturbances South of the Ash Pits

Visual inspections of the surface disturbance areas and reviews of historical use information pertaining to these sites will be completed prior to screening and sampling activities. A radiological survey will be completed at each area. Surface soil samples will be collected from the three excavations at IHSS 209 and from the north-south excavation at the surface disturbance south of the Ash Pits. A sediment sample and water sample (if water is present) will be collected from each of the former pond areas at

IHSS 209. Surface and subsurface samples will be collected from borings in the parallel excavations and the east and west areas at the surface disturbance south of the Ash Pits.

5.4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

Samples collected during the Phase I field investigation will be analyzed for the parameters specified in the IAG, as a minimum, as described in subsection 7.3. Analytical procedures will be completed in accordance with the ER Program QAPjP. Project-specific quality assurance (QA) requirements are included in the Quality Assurance Addendum (QAA), Section 10.0 of this work plan. Subsection 7.3 of this work plan specifies Phase I analytical requirements, as well as sample containers, preservation and holding times, and field quality control (QC) requirements. Samples collected for this work plan will be analyzed by a Rocky Flats Plant (RFP) contract laboratory.

Phase I data will be reviewed and validated according to the data validation guidelines in the QAPjP and the Data Validation Functional Guidelines (EG&G 1990a). These documents state that the results of data review and validation activities will be documented in data validation reports.

5.5 TASK 5 - DATA EVALUATION

Data collected during the Phase I Woman Creek drainage RI will be incorporated into the existing database and used to better define site characteristics, source characteristics, the nature and extent of contamination, to support the baseline risk assessment and environmental evaluation, and to evaluate potential remedial alternatives.

5.5.1 Site Characterization

Geologic and hydrogeologic data will be used to develop site maps and cross sections. Geologic data will be used to detail the stratigraphy of the alluvium and colluvium at each site and to determine the depth to bedrock and the bedrock type. Geologic data from boreholes will provide information on the size and depths of the Landfill and Ash Pits.

Hydrogeologic data will be used to characterize the unconfined aquifer at the sites. These data will include information about the following:

- Hydrostratigrapnic characteristics of units present
- Aquifer hydraulic parameters
- Hydraulic gradients
- Water table depth and configuration

To characterize the general groundwater flow regime within and adjacent to the IHSSs, groundwater flow modeling at an appropriate scale will be conducted. This flow modeling will initially consist of a single modeling project designed to include the IHSSs within OU5 and integrate consistently with sitewide groundwater flow modeling. The initial flow modeling will be used to construct flow paths from the IHSSs and to determine requirements for more detailed flow and transport modeling. Detailed flow and transport modeling will be done at the IHSS level as necessary.

To characterize the general surface water system of OU5, a regional scale surface water flow and transport model will be developed. This model will include the Woman Creek segments that exist on RFP site. The model will be integrated with pond models to simulate the Woman Creek system. The regional model may be expanded to include off-site segments as necessary. Where required, IHSS-specific flow and transport models will be developed and integrated to the regional scale model.

Data collected during surface water and sediment sampling, including background sampling, will be used to characterize Woman Creek, the SID, and the C-Series ponds.

5.5.2 Source Characterization

The data collected during the Phase I RI will be evaluated to identify potential sources of contamination at the IHSSs. Potential sources include wastes disposed at the sites and off-site sources located topographically and/or hydraulically upgradient of the sites. Analytical data from soil and sediment sampling at the sites will be used to characterize the nature, lateral and vertical extent, and volume of source materials, if present.

5.5.3 Nature and Extent of Contamination

Graphical and, where appropriate, statistical methods will be used to identify chemical and radioactive contaminants present in the soil, sediment, surface water, and groundwater and to estimate the concentrations and distributions of the contaminants. Results of sampling will be compared with results of the ongoing background geochemical characterization to asses if chemical concentrations are above background levels. Products of this analysis may include isopleth maps, cross sections and profiles, chemical tables, and statistical results.

5.6 TASK 6 - PHASE I BASELINE RISK ASSESSMENT

Using existing data and data collected during the tasks described above, a Phase I baseline risk assessment will be prepared for OU5 to evaluate the potential risks to public health and the environment in the absence of remedial action. The Phase I baseline risk assessment will provide the basis for determining whether additional investigations are necessary at the IHSSs and whether remedial actions are necessary.

The risk assessment will be accomplished in five general steps:

- Identification of chemicals of concern
- Exposure assessment
- Toxicity assessment
- Risk characterization
- Presentation of uncertainties and limitations of the analysis

The Phase I risk assessment will address the potential public health and environmental impacts associated with the site under the no-action alternative (no remedial action taken) based on the data available. This assessment will aid in the preliminary screening site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment.

The objectives and description of work for each risk assessment step are described in detail in the Baseline Risk Assessment Plan for OU5, Section 8.0 of this work plan. The Environmental Evaluation Work Plan for OU5 is Section 9.0 of this work plan.

5.7 TASK 7 - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

<u>Remedial Alternatives Development/Screening</u>

This section identifies potential technologies applicable to the remediation of contaminated soils, wastes, and groundwater at OU5. The identified technologies are based on the preliminary site characterization developed in Section 2.0. Identification and screening of technologies, assembling an initial screening of alternatives, and identification of potential interim remedial actions will be conducted while the RFI/RI investigation is being conducted. However, the investigation of this operable unit is in its early stages and thus remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives of each IHSS will be performed as more data are collected. It is important to recognize that additional phases of investigation may be required at some IHSSs prior to final screening of alternatives.

The process that will be employed to develop and evaluate alternatives for Operable Unit Number 5 is similar to the EPA Superfund process for selecting remedial alternatives. The Superfund Comprehensive Environmental Recovery, Compensation and Liability Act of 1980 (CERCLA) process is described in detail in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA 1988a). The CERCLA process was adopted because it specifies in the greatest detail the steps that should be followed for selection of remedial alternatives. In addition, the IAG requires general compliance with both Resource Conservation and Recovery Act (RCRA) and CERCLA guidance.

The steps followed to develop remediation alternatives for the Original Landfill (IHSS 115), Ash Pits 1-4 (IHSSs 133.1, 133.2, 133.3, 133.4), Incinerator (IHSS 133.5), Concrete Wash Pad (IHSS 133.6), Ponds C-1 and C-2 (IHSS 142.10 and 142.11) and Surface Disturbance (IHSS 209) areas are:

- Develop site remedial action objectives based on: chemical- and radionuclide-specific standards (when available); site-specific, risk-related factors; and other criteria, as appropriate.

- Develop preliminary risk-based remedial action goals for affected media. Preliminary remedial action goals will be applied as performance objectives (along with chemical-specific Applicable or Relevant and Appropriate Requirements [ARARs]) for evaluating the effectiveness of specific technology processes identified as candidate components of viable remedial action alternatives. Consistent with the National Contingency Plan (NCP), preliminary remediation goals will be established at a 1×10^{-6} excess cancer risk point of departure and at other intervals within the 1×10^{-4} to 1×10^{-6} decision range. As the Feasibility Study evolves, preliminary remediation goals may be revised to a different risk level based on consideration of appropriate factors including, but not limited to: exposure, uncertainty, and technical issues.

- Develop a list of general types of actions appropriate for the IHSS areas constituting OU5 (such as containment, treatment, and/or removal) that may be taken to satisfy the objectives defined in the previous step. These general types or classes of action are generally referred to as "general response actions" in EPA guidance.

- Identify and screen technology groups for each general response action. For example, the general response action for containment can be further defined to include the in situ stabilization of contaminants in a form that is less mobile or immobile in the environment. Other containment alternatives could consist of groundwater barriers, such as slurry walls. Screening will eliminate those groups that are not technically feasible at the site.

- Identify and evaluate process options for each technology group to select a representative process for each group under consideration. Although specific process options are selected for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group. For example, a soil bentonite slurry wall may be selected as representative of vertical barriers and would be used for technical and cost comparisons.

- Assemble the selected representative technologies into potential interim response actions for each IHSS, if appropriate.

- Assemble the selected representative technologies into site closure and corrective action alternatives for the IHSS areas comprising OU5 that represent a range of treatment and containment combinations, as appropriate.

- Screen the assembled alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the purpose of the screening evaluation is to reduce the number of alternatives that will undergo a thorough and extensive analysis, alternatives will be evaluated in less detail than subsequent evaluations.

"Effectiveness" is an evaluation of the protectiveness of human health and the environment achieved by a remedial alternative action during construction and implementation and after the response objectives have been met. Evaluation of effectiveness in the short term is based on protection of the community and workers, impacts to the environment, and the time required to meet remedial response objectives. Long-term evaluation of effectiveness addresses the risk remaining to human health and the environment and is based on the percent permanent destruction of, the decreased mobility of, and/or the reduction in volume of toxic compounds achieved after response objectives have been met.

"Implementability" is a measure of both the technical and administrative feasibility of constructing and operating and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to site-specific conditions. "Technical feasibility" refers to the ability to construct, reliably operate, and comply with action-specific (technology-specific) requirements in order to complete the remedial action. "Administrative feasibility" refers to the ability to obtain required permits and approvals; to obtain the necessary services and capacity for treatment, storage, and disposal of hazardous wastes; and to obtain essential equipment and technical expertise.

Cost estimates for screening will be derived from cost curves, generic unit costs, vendor information, conventional cost estimating guides, and prior estimates made for Rocky Flats and similar sites, with modifications made for Rocky Flats Plant conditions. Absolute cost accuracy is not necessary, but cost estimates should have the same relative accuracy for comparison and screening. The cost estimating procedures used during screening are similar to those that will be used during the later, detailed alternatives analysis. The later, detailed analysis, however, will receive more in-depth and detailed cost estimates for the components of each alternative. The screening cost estimates will include capital, operating, and maintenance costs. The operating and maintenance costs will be calculated for the lifetime of the treatment unit operation at the site. Present-worth cost analysis will be used for alternatives to make the costs for the various alternatives comparable.

Alternatives with the most favorable results from the composite evaluation will be retained for further scrutiny during the detailed analysis. Not more than 10 alternatives will be retained for detailed analysis (including containment and no-action alternatives). At that time, it may be determined that additional site-specific information or technology-specific treatability studies are necessary for an objective detailed analysis. Also, it will be necessary to identify and verify the action-specific ARARs that each respective alternative will be required to meet.

For the Phase I RFI/RI work plan, the appropriate level of alternatives analysis is the listing of general response actions most applicable to the type of site under investigation. General response actions are defined as those broad classes of actions that may satisfy the objectives for remediation defined for OU5. Table 5-1 provides a list and description of general response actions and typical technologies associated with remediating soils, groundwater, sediments, and surface water. Table 5-1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways. Not all of the alternative response actions and typical technologies listed may be appropriate for the IHSSs comprising OU5. Some will be discarded during the screening of alternatives.

The response actions outlined in Table 5-1 must be applied to the potential exposure pathways that will be identified for OU5. The response actions can be capable of providing control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that provide control over all pathways.

In general terms, potential human exposure may be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where the contact could occur with the released contaminant.

The existing data regarding the site hydrogeologic characteristics and potential soil and groundwater contamination are not sufficient for implementing the screening process. The IAG and this work plan

TABLE 5-1

GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION

General Response Action	Description	Applicability of General Response Typical Technologies	Action to Potential Pathways
No Action	No remedial action taken at site.	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control onsite contact.
Access and use restrictions	Permanent prevention of entry into contaminated area of site. Control of land use.	Site security; fencing; deed use restrictions; warning signs.	Could control onsite exposure and reduce potential for offsite exposure. Site security fence and some signs are in place. Additional short-term or long-term access restriction would likely be part of most remedial actions.
Containment	In-place actions taken to prevent migration of contaminants.	Capping; groundwater containment barriers; soil stabilization; enhanced vegetation.	If applied to source, could be used to control all pathways. If applied to transport media, could be used to mitigate past releases (except air).
Pumping	Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal.	Groundwater pumping; leachate collection; liquid removal from surface impoundments.	Applicable to leachate removal prior to in situ treatment or waste removal. Applicable removal of contaminated groundwater and bulk liquids (for example, from buried drums).
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of drums, soils, sediments, wastes, contaminated structures.	If applied to source, could be used to control all pathways. If applied to transport media, will control corresponding pathway. Must be used with treatment or disposal response actions to be effective.

TABLE 5-1
GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION
(Concluded)

General Response Action	Description	Applicability of General Response Typical Technologies	Action to Potential Pathways
Treatment	Application of technology to change the physical or chemical characteristics of the contaminated material. Applied to material that has been removed.	Solidification; biological, chemical, and physical treatment.	Applied to removed source material; could be used to control all pathways. Applied to removed transport media, could control air, surface water, groundwater, and sediment pathways.
In Situ Treatment	Application of technologies in situ to change the in-place physical or chemical characteristics of contaminated material.	In situ vitrification; bioremediation.	Applied to source, could be used to control all pathways. Applied to transport media, could be used to control corresponding pathways.
Storage	Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal.	Temporary storage structures.	May be useful as a means to implement removal actions, but definition would not be considered a final action for pathways.
Disposal	Final placement of removed contaminated material or treatment residue in a permanent storage facility.	Permitted landfill; repositories.	With source removal, could be used to control all pathways. With removal of contaminated transport media, could be used to control corresponding pathway (except air).
Monitoring	Short- and/or long-term monitoring is implemented to assess site conditions and contamination levels.	Sediment, soil, surface water, and groundwater sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.

indicate that the following information will be collected during the Phase I RFI/RI for the characterization of the source and groundwater contaminants and for the preliminary screening of alternatives:

- Describe contaminant fate and transport
  - Collect and analyze soil and groundwater samples below and hydraulically downgradient of potential release areas to evaluate contaminant spread
  - Collect groundwater samples at selected locations to evaluate contaminant distribution
  - Collect and analyze surface water and sediment samples at the Detention Ponds
  - Collect sediment/surface soil samples in the creek/stream and Interceptor Ditch beds
  - Collect surface soil samples at the Ash Pits, Incinerator, and around the Concrete Wash Pad
  - Describe and characterize hydrogeology beneath all IHSS areas

- Site physical characterization
  - Groundwater flow regime within the unconfined aquifer
  - Soil types and general engineering properties
  - Surface water flow regime
  - Depth to groundwater and saturated thickness

These data will provide for a comparative evaluation of the technologies with respect to implementability, effectiveness, and cost, and will allow for informed decisions to be made with respect to the selection of preferred technologies. The FSP (Section 7.0) describes the methodology that will be followed to obtain the required information.

<u>Detailed Analysis of Remedial Alternatives</u>

It is unlikely that sufficient data will be generated during the Phase I investigation to allow a detailed analysis of remedial alternatives. The detailed analysis of each alternative will be performed when sufficient data is generated during the remedial selection process. The detailed analysis is not a decision-making process, but it is the process of analyzing and comparing relevant information in order to select a remedial action. Each alternative will be assessed against nine evaluation criteria, and the assessments will be compared to identify the key tradeoffs among the alternatives. Assessment against the nine evaluation criteria is necessary for the Feasibility Study (FS) and the subsequent Record of Decision (ROD)/Corrective Action Decision (CAD) to comply with the CERCLA/RCRA ARARs. The nine specific evaluation criteria are:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

These criteria are described in the CERCLA EPA guidance document (U.S. EPA 1988a). The initial two criteria are considered threshold criteria because these alternatives must be satisfied before further consideration of the remaining criteria. The next five criteria are considered the primary criteria on which the analysis is based. The final two criteria, state and community acceptance, are addressed during the final decision-making process after completion of the Corrective Measure Study/Feasibility Study (CMS/FS).

5.8 TASK 8 - TREATABILITY STUDIES

This task includes efforts to provide technical support in the form of bench-scale treatability tests to the Rocky Flats Plant ER Program in the event that treatability studies are necessary or appropriate to support the OU5 RFI/RI.

Treatability studies are conducted primarily to: (1) provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis, and to support the design of a selected remedial alternative; and (2) reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. Treatability study requirements are developed during the development and screening of remedial alternatives (subsection 5.7) and include all available data from the current study as well as prior studies.

Numerous technologies that appear to be potentially applicable for treating OU5 will be screened for treatability testing. The technologies selected for screening will be limited to those already commercially established or which have demonstrated potential for processing spent solvents, radionuclides, oils, and similar contaminants. Additionally, the technologies considered will be required to be readily implementable (i.e., standard design package units available) within a short time frame. Innovative and alternative technologies not meeting the above requirements will not be considered.

Depending on the hydraulic properties of the unconfined aquifer considered for remediation, it may be feasible to collect groundwater for treatment above ground. In that case, the following technologies have been identified for potential testing:

- Chemical Oxidation of Organics - Chemical oxidation is used to degrade hazardous organic materials to less toxic compounds. Oxidation systems, particularly those using ultraviolet (UV) light, ozone, and hydrogen peroxide, are powerful tools for treating a wide variety of common organic environmental contaminants. Disadvantages are similar to those for inorganic oxidation reduction: potential nontarget organics and inorganics can produce undesirable side products and increase oxidant requirements.

- Granular Activated Carbon (GAC) Adsorption of Organics - GAC adsorption is the most fully developed and widely used technology for treating groundwater contaminated with organics. It is effective for the removal of a wide range of organics from aqueous waste streams. Bench-scale testing consists of running a series of descriptive tests to determine isotherms for the groundwater contaminants. GAC is typically regenerated with a thermal process, and the regeneration process can be performed at either off-site or on-site facilities.

- Reverse Osmosis - Reverse osmosis processes involve the use of semipermeable membranes. By applying water pressure greater than the osmotic pressure to one side of the membrane, water is passed through the membrane while particulate, salts, and high molecular weight organics are retained. However, the retained, highly concentrated solution (retentate) contains dissolved salts as well as the target contaminants, and requires further treatment or disposal.

- Air Stripping - Air stripping is a proven technology for removal of volatile and semivolatile contaminants from water. This process involves the transfer of contaminants from a contaminated liquid phase to a vapor phase by passing the two countercurrent streams through a packed tower. Air emission treatment is generally required, with vapor phase activated-carbon systems being the most commonly used process for this purpose, though other alternatives, such as oxidation and incineration, exist. The vapor phase treatment unit is generally costly.

- Distillation - Distillation is a process that involves separating compounds by means of their boiling point characteristics. The primary use of distillation is for reclaiming spent solvents from industrial processes, and it is generally applicable only to rather concentrated solutions. The process can be used to separate various volatile compounds or to separate mixtures of organics into light and heavy fractions. The light fraction can usually be recycled or used as a boiler feed, while the heavy fraction requires further treatment.

- Biological Reactors - Biological reactors utilize microorganisms to remove organic contaminants from the water. Most organic contaminants can be biologically degraded by introducing the appropriate microorganisms. High concentrations of some organics and the presence of metals may prove toxic to the organisms, however, and pretreatment may be required. Several types of aerobic reactors exist, including activated sludge systems, trickling filters, rotating biological contactors, and immobilized cell reactors. In general, these methods generate large amounts of sludge, requiring disposal.

- Sorption of Radionuclides - Sorption of inorganics, metals, and radionuclides is a standard technique for removal and concentration of these contaminants from wastewater. Common and proven sorption processes include ion exchange and GAC, while less-proven techniques involve the use of activated alumina, bone char, and proprietary sorption media. The sorption media are generally chemically regenerated, which results in a concentrated side stream requiring further treatment or disposal. Ion exchange and GAC sorbents are addressed separately elsewhere in this subsection, while the use of activated alumina and bone char are discussed below.

  Activated alumina is a porous form of aluminum oxide with a large surface area. For removal of aqueous contaminants, activated alumina is typically used in a column similar to that for ion exchange. It has been proven successful in the removal of arsenic and fluoride from groundwater (Rubel 1980). More recently, activated alumina has shown promise in absorbing plutonium from a low-level wastewater effluent at the Hanford Site (Barney et al. 1989). In the same study, plutonium adsorption on bone char was the most rapid and gave the highest decontamination factors. Waste-stream-specific laboratory testing would provide valuable information on the suitability of these sorbents for low-level radionuclide removal.

- Ion Exchange of Radionuclides - Ion exchange processes are used for a wide range of water treatment application, including commonly recognized systems such as demineralizers and water softeners. The goal of an ion exchange system is to remove undesirable ions of a certain type(s) from a solution and replace them with more acceptable ions. Radionuclides are commonly removed from waste streams at nuclear facilities using ion exchange.

Ion exchange resins, particularly anion exchange resins, have been used to recover uranium from mine run-off water for many years. Extensive studies on the laboratory scale report removal of uranium from natural waters as high as 99 percent (Sorg 1988). A small full-scale ion exchange system was capable of removing uranium from drinking water supplies to as low as 1μg/l (Jelinek and Sorg 1988). Ion exchange resins are typically rechargeable; however, the resins used in radioactive applications are generally only used once and are then disposed of as solid waste. Although published information in the removal of plutonium from natural waters by ion exchange has not been found, there is indication that ionized plutonium is removable using this technology (Marston 1990).

In cases where collection of groundwater is not feasible or practical, the following technologies have been identified for potential testing:

- In Situ Biological Treatment - Depending on the effective porosity of the soils, in situ biological treatment may be feasible. In situ biological treatment of groundwater involves the stimulation of biological growth in the contaminated zone in order to reduce the contaminant concentrations. Microorganisms that can use some or all of the contaminants as substrates will normally exist in a contaminated environment. The microorganisms are stimulated to increase their biological growth and consumption of contaminants through addition of essential nutrients. Aerobic treatment systems also require the introduction of oxygen. In situ treatment is dependent on geological and hydrological conditions. The process is relatively inexpensive.

- Vacuum Extraction - Volatile contaminants can be removed from soil using vacuum extraction, which is an in situ treatment technology that involves the air stripping of contaminants by inducing a vapor flow through the soil. Since this technology involves the transfer of contaminants to the vapor, air emission treatment is generally required. The efficiency of the process is highly dependent on geologic conditions, and would tend to be ineffective in low-permeability materials.

In cases where contaminants are entrained in soils, the soil (such as surface soil) is accessible, and the contamination is of limited areal extent, the following technologies have been identified for potential testing:

- Solidification/Stabilization - Solidification is a process in which contaminants are mechanically bound to solidification agents, reducing their mobility. This produces a solid matrix of waste with high structural integrity. Stabilization usually involves the addition of a chemical reagent to react with the contaminant, producing a less mobile or less toxic compound. Solidification and stabilization are frequently used together and are a well-established method for reducing the mobility and toxicity of hazardous wastes. This process generates large volumes of solidified materials requiring disposal.

- Vitrification - The vitrification process involves heating the waste matrix to a very high temperature and either combining the matrix with molten glass or heating the matrix until it melts. Once cooled, the molten mass solidifies into a stable, noncrystalline solid resistant to leaching of inorganic, metal, and radionuclide contaminants. Organic components are destroyed by pyrolysis. The process can be conducted either in situ or off site; however, the process is generally expensive.

- Physical Separation - Soil contaminants are often found to be associated with a particular size fraction of soils, most often fine particles. In these cases, fractionation of the soil based on particle size can be an effective means of reducing the volume of the material that requires further treatment. The processes used for soil size fractionation include screening, classification, flotation, and gravity concentration.

- Soil Washing - Soil washing is based on the principle of contaminant removal from soil by washing with two liquid solutions. Washing agents include water, acids, solvents, surfactants, and chelators. With the selection of appropriate washing solutions, soil washing technology can potentially be used to remove organics, inorganics, metals, and radionuclides. The wash solution containing the contaminants will require treatment and/or disposal.

5.9 TASK 9 - REMEDIAL INVESTIGATION REPORT

An RI report will be prepared summarizing the data obtained during the Phase I field work and data collected from previous and ongoing investigations. This report will:

- Describe in detail the field activities that serve as a basis for the RI report. This will include any deviations from the work plan that occurred during implementation of the field investigation.

- Discuss site physical conditions. This discussion will include surface features, meteorology, surface water hydrology, surficial and subsurface geology, groundwater hydrology, demography and land use, and ecology.

- Present site characterization results from all RFI/RI activities at OU5 and characterize the nature and extent of contamination. The media to be addressed will include contaminant sources, soils, sediments, groundwater, surface water, air, and biota.

- Discuss contaminant fate and transport. This discussion will include potential migration routes, contaminant persistence, chemical attenuation processes and potential receptors.

- Present a baseline risk assessment. The risk assessment will include human health and environmental evaluations.

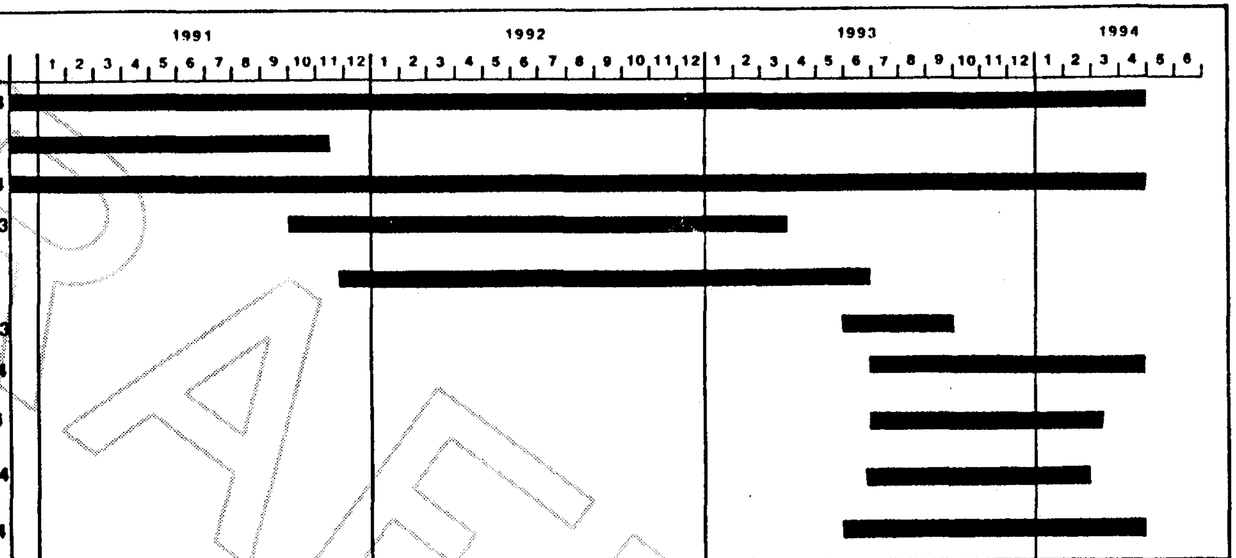
- Present a summary of the findings and conclusions.

- Identify data gaps for later phases of this investigation.

6.0
SCHEDULE

The schedule for conducting the Phase I Remedial Investigation is summarized in Figure 6-1. Dates shown are from the Interagency Agreement (IAG), dated January 22, 1991. According to the schedule, approximately 3 years will elapse from the time this work plan is finalized until the Phase I Remedial Investigation Report is issued.

ACTIVITY	DATES START	DATES FINISH
PROJECT MANAGEMENT	4 Sep,90	3 May,94
TASK 1 - PROJECT PLANNING	4 Sep,90	6 Nov,91
TASK 2 - COMMUNITY RELATIONS	4 Sep,90	3 May,94
TASK 3 - FIELD INVESTIGATION	2 Oct,91	30 Mar,93
TASK 4 - SAMPLE ANALYSIS & DATA VALIDATION	14 Nov,91	1 Jul,93
TASK 5 - DATA EVALUATION	4 Jun,93	29 Sep,93
TASK 6 - BASELINE RISK ASSESSMENT	25 Jun,93	3 May,94
TASK 7 - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES	25 Jun,93	2 Mar,94
TASK 8 - TREATABILITY STUDIES	25 Jun,93	24 Feb,94
TASK 9 - PHASE I REMEDIAL INVESTIGATION REPORT	4 Jun,93	3 May,94



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

PHASE 1 RFI/RI SCHEDULE

FIGURE 6-1 MARCH 1991

7.1 BACKGROUND AND SAMPLING RATIONALE

7.1.1 Background

The objectives of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) are:

- To characterize the physical and hydrogeologic setting of the Individual Hazardous Substance Sites (IHSSs)
- To assess the presence or absence of contamination at each site
- To characterize the nature and extent of contamination at the sites, if present
- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

Within these broad objectives, site-specific data needs have been identified in Section 4.0. The purpose of this section of the work plan is to provide a Field Sampling Plan (FSP) that will address data needs and data quality objectives. The FSP developed in this section is based on the requirements of the IAG Statement of Work for OU5, and the data needs developed in Section 4.0. It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs prior to feasibility studies.

Generally, only limited information is available concerning the IHSSs in Operable Unit Number 5 (OU5) since there have been no previous field investigations of these sites. Available information includes aerial photographs, site histories, and some analytical data for samples collected near the IHSSs. Little information exists specific to the physical characteristics of the sites or to the nature and extent of the contamination, if present.

One of the objectives of the RFI/RI is to assess the presence or absence of contamination in the groundwater, surface water, and soils at the sites. A stepped approach is outlined in the IAG and will be used in Phase I to achieve this objective. This approach uses an iterative process involving continuing reassessment of the site conditions as data are obtained. Based on this process, the subsequent field sampling program may be modified to collect more representative data for each IHSS. This FSP describes this stepped process.

Based on the previous investigations and historical data presented in Section 2.0 of this report, the primary potential contaminants of concern are metals and radioactive materials. Insufficient data exists to confirm or deny the presence of organic compounds in IHSSs within OU5.

7.1.2 Sampling Rationale

As discussed above, a stepped approach will be used for the sampling program. There are four steps which may be completed at any site.

- Step 1 consists of a review of existing data, including aerial photographs and site records. Data from ongoing or other operable unit investigations that have become available since preparation of this Phase I work plan will be compiled and evaluated. These data will be validated as appropriate for incorporation into the OU5 site characterization. This review of existing information has already been partially performed during preparation of this Phase I work plan.

- Step 2 involves screening activities, including radiation surveys and a soil gas survey at the Original Landfill area. These activities are designed to provide Phase I screening-level data concerning the presence or absence of contaminants at the sites.

- Step 3 consists of Phase I sampling activities for soil, sediment, and surface water. Soil borings will be completed at some IHSSs to collect samples at depth and to characterize the IHSS. Some of the sampling locations may be selected to investigate anomalies identified in the Step 2 soil gas and radiation surveys. This step will provide confirmation of the Phase I screening data as well as aid in Phase I geologic and hydrogeologic characterization of the sites.

- Step 4 is monitoring well installation and sampling, which will follow Step 3 Phase I characterization and sampling. Groundwater monitoring wells will be installed to characterize the hydrogeologic setting of each site and to monitor alluvial groundwater conditions within or downgradient of several sites. These wells will be sampled after completion and development, and the results will be included in the Phase I RFI/RI Report.

7.1.3 Modifications to the IAG Plan

Several sampling and analytical activities described in the Interagency Agreement (IAG) have been modified in this FSP. These modifications, listed below, have been made so that each IHSS can be better evaluated during the Phase I investigation. Modifications to the Phase I sampling program are presented first followed by modifications to the Phase I analytical program.

Phase I Sampling Program Modifications

1) Radiation surveys and limited soil sampling will be conducted at the Surface Disturbance areas. The purpose of these activities is to assess the presence or absence of contaminants at these sites. The rationale for this sampling is that if contamination is not found, the surface disturbances can be removed from further phases of the RFI/RI process.

2) An investigation of a second surface disturbance (south of the Ash Pits) has been added to the Phase I investigation. This is an area where unknown activities have taken place at excavation and fill areas. The investigation of this area will include a review of the aerial photos, a radiation survey, surface soil sampling, and nine soil borings. Details of this program are contained in subsection 7.2.4.

3) No FIDLER radiation survey will be conducted at the Original Landfill (IHSS 115). This survey has been deleted from the Phase I investigation because a more comprehensive gamma radiation survey using a germanium detector was completed in the fall of 1990.

4) Two-foot composite samples will not be used for volatile or semivolatiles organics analysis at the Original Landfill (IHSS 115). Instead, discrete samples will be collected at two-foot increments for analysis. Composite samples are not appropriate for analysis of organic compounds, since a significant portion of the volatiles present in a sample can be volatilized during compositing of a sample.

5) Five sediment samples are to be collected from both Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), as proposed in the IAG. However, three of the five locations have been changed so that more representative samples of the pond sediment can be obtained. The five locations proposed in this Phase I FSP are:

   - In the deepest portion of the pond,
   - In the pond, five feet from the inlet, and
   - At three randomly selected locations within the pond.

   The samples to be collected at the three random locations are the locations which have been changed from those specified in the IAG. These random samples will provide pond sediment data that can be statistically averaged, while the samples collected from the deepest part of the ponds are likely to provide worst case concentrations. These average and worst case concentrations can then be used to better characterize the extent and nature of any contamination in the ponds and provide more useful data for the Phase I baseline risk assessment. The three original sampling locations specified in the IAG would provide non-random data that cannot be used in statistical analyses.

6) Seven borings will be drilled and sampled in the Original Landfill (IHSS 115) area. One boring will be drilled at the location of the former pond and six borings will be drilled in the disturbed area east of the landfill. The borings will be drilled 3 feet into weathered bedrock. Samples will be analyzed for the same constituents as other soil samples from the landfill. There have been no previous investigations in either the area of the former pond or the disturbance east of the landfill. These borings will provide Phase I data concerning the presence or absence of contamination at these locations.

7) Four Phase I background sediment and surface water samples will be collected along the Woman Creek drainage. One of the four samples will be collected in Woman Creek adjacent to its crossing of the South Boulder Diversion Canal. Two additional background samples will consist of two sediment and two surface water samples collected west of Highway 93. One sediment and one surface water sample will be collected in the ditch connecting Rocky Flats Lake with Woman Creek. The water samples will be collected quarterly for one year. These data, along with other site background data, will be used to: (1) characterize the surface water quality upgradient of the IHSSs so that contaminant concentrations measured adjacent to the IHSSs can be evaluated to determine if they are characteristic of upgradient (background) conditions or represent contamination from an IHSS or other source; and (2) establish preliminary baseline water quality for Woman Creek.

Phase I Analytical Program Modifications

1) All the Phase I soil samples collected from the Ash Pits area (IHSSs 133.1-133.6) will be analyzed for metals as well as for uranium, gross alpha, and gross beta radiation. This should provide a more representative analysis of the wastes thought to be present in these pits. This is also appropriate, since the groundwater monitoring program calls for analysis of metals in wells downgradient of this IHSS. Details of this analytical program are summarized in subsection 7.3.2.

2) A gamma radiation scan will be conducted by EG&G or its contractor on each of the sediment samples collected from the location at the deepest portion of Ponds C-1 and C-2 (IHSSs 142.10 and 142.11). Sediment samples at these locations will be collected from the sediment core at five-centimeter intervals. The rationale behind including this analysis is to evaluate whether

contamination may exist in thinly stratified layers and to provide additional data to characterize pond sediment.

3) The IAG specifies that water and sediment samples be analyzed for soluble and insoluble radionuclides and metals. For the purposes of this Phase I investigation, each of the water samples will be filtered, and both the filtered and unfiltered aliquots analyzed for the specified metals and radionuclides. The filtered sample will provide data on the dissolved constituents and the unfiltered sample will provide data on the total constituent concentrations. Also, water (both filtered and unfiltered) and sediments will be analyzed for both plutonium isotopes (239/240). This is consistent with the existing Rocky Flats analytical methods.

4) Several analyses have been added to the Phase I analytical program to address chemicals of interest in the Environmental Evaluation. Groundwater samples from wells installed at the Original Landfill (IHSS 115) and one-half of the sediment samples collected in Woman Creek will be analyzed for TCL pesticides/PCBs. All surface (0-2 inches) soil samples taken in OU5 and sediment samples collected in Woman Creek will be analyzed for total organic carbon (TOC).

7.2 PHASE I INVESTIGATION PROGRAM

This section describes the Phase I investigation program for the IHSSs within OU5. For each IHSS, the tasks listed are generally divided into office activities prior to field sampling (Step 1), field screening activities prior to sampling (Step 2), field sampling activities (Step 3), and groundwater monitoring well installation and sampling (Step 4). As part of the field sampling program, data from the site-wide monitoring program will be used as appropriate to add to, or substitute for, the data collected during the Phase I investigation. The sites included within OU5 are IHSS 115 - Original Landfill; IHSS 133 - Ash Pits 1-4, the Incinerator, and the Concrete Wash Pad; IHSS 142.10 and 142.11 - C-Series Detention Ponds; and IHSS 209 - Surface Disturbance Southeast of Building 881. In addition, a second surface disturbance south of the Ash Pits will also be evaluated. For reference, the Phase I investigation programs for each IHSS are summarized in Tables 7-1 through 7-4. A number of standard operating procedures (SOPs) will be used during the investigation. The SOPs are cited in this section and discussed further in Section 11.0 of this Phase I work plan.

7.2.1 IHSS 115 - Original Landfill

Step 1 - Review Aerial Photographs

Aerial photographs taken during operation of the Original Landfill will be reviewed to identify the extent of the Original Landfill and the disturbed area located to the east of the Original Landfill. The areas to

TABLE 7-1

PHASE I INVESTIGATION
IHSS 115 - ORIGINAL LANDFILL

Activity	Purpose	Location	Sample Number
Review Aerial Photographs	Identify extent and area east of Landfill	Entire site and eastward	NA
Review Radiation Survey	Identify radiation hotspots		NA
Soil Gas Survey	Locate plumes of volatile organics	Entire site and eastward - 100 ft. grid	65
Soil Cores	Verify presence or non-presence of volatiles identified during soil gas survey	Random basis, 1 sample every 50 soil gas samples, at the depth of the soil gas probe	2
Soil Borings	Characterize subsurface conditions and contamination	One in the area of the former pond, six in the disturbance east of the Landfill. Borings will be drilled at least 3 feet into weathered bedrock.	7
Soil Borings (if plumes are identified)	Transect plumes identified by soil gas survey, if identified	Three borings transecting three highest soil gas locations. Borings will be placed at point of highest reading and two locations downslope of the point. Borings will be drilled at least 3 ft. into weathered bedrock.	Maximum of 9
Complete wells in borings (if plumes are identified)	Monitor alluvial groundwater in plume, if identified	In borings at the points of highest readings	Maximum of 3
Install wells	Monitor alluvial groundwater downgradient of the unit	See Figure 7-1	3
Review plant plans, conduct sewer snake survey	Confirm interconnections of two pipes daylighting in the Landfill	Two pipes in Landfill	NA
Sample effluent (if present)	Characterize effluent from the pipes	Pipe outfalls	2
Sample sediment and surface water	Characterize sediment and surface water downgradient of the unit	Three locations along S.I.D., two locations on Woman Creek	5 each sediment and surface water

NA - Not Applicable

TABLE 7-2

PHASE I INVESTIGATION
IHSS 133 - ASH PITS 1-4, INCINERATOR,
AND CONCRETE WASH PAD

Activity	Purpose	Location	Sample Number
Review Aerial Photographs	Identify extent of the areas, including areas beyond the boundaries of the units	Entire site and north of road	NA
Radiation Survey	Locate radiation hotspots	Entire site - 10-foot grid	NA
Surface Soil Sampling	Characterize radiation hotspots	Central location of areas of radiation above background	Unknown
Soil borings	Characterize subsurface conditions and contamination	On 25-foot centers and over hotspots. Borings will be drilled 5 ft. into weathered bedrock.	85
Install wells	Monitor alluvial groundwater downgradient of the unit	See Figure 7-3	3

NA - Not Applicable

TABLE 7-3

PHASE I INVESTIGATION
IHSS 142.10-11 - C-SERIES DETENTION PONDS

Activity	Purpose	Location	Sample Number
Collect surface water samples	Characterize surface water contamination	5 locations in each pond and from each vertically stratified zone at the deepest point in the pond	16
Collect sediment samples in ponds	Characterize sediments in ponds and contamination	5 locations in each pond. Samples will also be taken from each 5 centimeter interval of sediment from the deepest part of each pond.	10
Collect sediment samples in other locations on Woman Creek	Characterize Woman Creek sediments and contamination	See Figure 7-2 and text	18
Collect sediment samples in the South Interceptor Ditch	Characterize South Interceptor Ditch sediments and contamination	See Figure 7-2 and text	10
Collect background sediment and surface water samples in Woman Creek	Characterize background levels in Woman Creek	Four locations west of the Plant on or near Woman Creek	4 surface water and 4 sediments
Install wells	Monitor alluvial groundwater downgradient of the ponds	Below ponds C-1 and C-2 dams (2 each)	4

TABLE 7-4

PHASE I INVESTIGATION
IHSS 209 - SURFACE DISTURBANCE SOUTHEAST OF BUILDING 881 AND SURFACE DISTURBANCES SOUTH OF THE ASH PITS

Activity	Purpose	Location	Sample Number
Review Aerial Photographs	Evaluate nature and use of sites and nature of the pond at IHSS 209	IHSS 209 and surface disturbance south of the Ash Pits	NA
Visual Inspection	Identify stained soil areas	IHSS 209 and surface disturbance south of the Ash Pits	NA
Radiation Survey	Location radiation hotspots	Random survey over area	NA
Sample Sediment and Surface Water	Characterize the two ponds on IHSS 209	From the center of the ponds at IHSS 209	2 each sediment and surface water
Soil Borings	Evaluate surface disturbances south of Ash Pits	2 in each of the parallel excavations, 4 in west area, and 1 in east area	9
Sample soil	Evaluate potential contamination in small depressions in IHSS 209	One sample from each of the small depressions	3
Surface Sample	Evaluate potential contamination in surface disturbance south of Ash Pits	One in north-south excavation, and at stained areas and radiation hotspots	1 and unknown

NA - Not Applicable

be studied during later steps of this investigation, including the location of the former pond, will be delineated from the aerial photographs. Additional studies conducted at the Landfill after preparation of this Phase I work plan will be evaluated during Step 1 (see Table 7-1). Also as part of Step 1, the gamma radiation survey conducted at the Original Landfill using a germanium detector will be reviewed.

Step 2 - Soil Gas Survey

A real-time soil gas survey will be conducted over the Original Landfill and the disturbed area located to the east of the Landfill (Figure 7-1). As specified in the IAG, the soil gas samples will be taken on a 100-foot grid according to the procedures described in SOP 3.9. It is anticipated that a method utilizing a hand-driven probe may be necessary on the steep slopes of the Landfill. The probe will be driven approximately 2 feet into the soil to collect the soil gas. The soil gas samples will be analyzed for 1,1,1-trichloroethane (TCA), dichloromethane, benzene, carbon tetrachloride, tetrachloroethene (PCE), and trichloroethene (TCE). Analytical peaks of compounds for which the gas chromatograph (GC) is not calibrated will be noted. The soil gas survey will be conducted using a portable GC. The analytical program for the soil gas survey is discussed in subsection 7.3.2.

Step 3 - Soil Cores, Soil Borings, Surface Water, and Sediment Samples

Soil cores will be collected on a random basis to verify the soil gas survey. One soil core will be collected for every 50 soil gas samples at the same depth as the soil gas samples. Based on the number of soil gas sampling locations, it is estimated that two soil cores will be collected. One soil boring will be drilled in the location of the former pond. Six soil borings will be drilled in the disturbed area east of the landfill. If plumes are identified by the soil gas survey, soil borings will be utilized to transect the plumes. Three borings will be placed at up to three areas where plumes have been identified by the soil gas. This will result in a maximum of nine soil borings being drilled at the three plume areas. At each plume area one soil boring will be placed at the point of the highest soil gas reading and two borings will be located downslope of that point. As specified in the IAG, each soil boring will be drilled at least 3 feet into weathered bedrock according to the procedures described in SOP 3.2. Samples will be taken continuously in these borings. Discrete samples will be collected from every 2-foot increment and analyzed for the Target Compound List (TCL) for volatile and semivolatile organic compounds. Samples will be composited from every 6-foot interval and analyzed for the Total Analyte List (TAL) for metals and radionuclides. The analytical program for those samples is presented in subsection 7.3.

During sampling a soil classification survey will be completed at the Original Landfill for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

The two corrugated metal pipes protruding from the Landfill (Figure 7-1) will also be investigated in this FSP. Plant plans will be reviewed and a sewer snake survey will be conducted to attempt to identify the open length of the pipes and the sources of water. This survey may use a traceable electronic or magnetic source attached to the snake such that surface instruments can be used to follow the path of the pipe. Other methods for locating pipes may also be used if the sewer snake survey is inconclusive. If water is found to be flowing through either of the corrugated pipes during this Phase I investigation, the effluent will be sampled according to SOP 4.3. Results of the sampling will be reported in the Phase I RI Report.

The sediments and surface water of the South Interceptor Ditch (SID) and Woman Creek will be sampled immediately downgradient of the Original Landfill. These locations are shown in Figure 7-2, which is a map of all the proposed surface water and sediment sampling locations for OU5. A sediment sample and a surface water sample will be collected at three locations along the SID and two locations on Woman Creek according to the procedures specified in SOP 4.6 for sediments and SOPs 4.2 and 4.3 for surface water. The sediment samples will be collected in areas of the creek or ditch that are conducive to sediment accumulation. The analyses to be performed on these samples are listed in subsection 7.3.

During sampling a soil classification survey will be completed at the Ash Pits for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

Step 4 - Monitoring Wells

If soil borings are used to transect soil gas plumes, monitoring wells will be installed in the borings with the highest soil gas readings. A maximum of three monitoring wells will be installed in these borings. As specified in the IAG, all of these wells will be installed in the alluvium just above the bedrock according to SOP 3.6.

In addition to the above wells, three monitoring wells will be installed in the alluvial aquifer downgradient of the Original Landfill between the Landfill and the SID (Figure 7-1). The first well will be placed between the western leg of the Landfill and the SID. The second well will be placed in the alluvium in the surface drainage north of Well 5786 between the Landfill and the SID within the area of the old embankment. The third well will be placed in the alluvium between the southeastern corner of the boundary of IHSS 115 and the SID, downgradient of the outfall identified on the east side of the Landfill. These three wells should monitor the principal groundwater migration pathway downgradient of the Original Landfill.

The three proposed groundwater monitoring wells will be drilled according to SOP 3.2 and installed according to SOP 3.6. All wells will be developed according to SOP 2.2. Following development, wells will be sampled according to SOPs 2.5 and 2.6. The analyses to be performed on these samples are listed in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. The three monitoring wells downgradient of the Landfill will be sampled quarterly for one year.

7.2.2 IHSS 133 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad

Step 1 - Review Aerial Photographs

Aerial photographs from 1953, 1964, 1969, and 1978 through 1988 will be reviewed to identify the extent of the disposal areas for these sites including an area north of the west access road and possible waste disposal areas beyond the boundaries of Ash Pit 1 and the Concrete Wash Pad (see Section 2.0). The dimensions of each pit, determined from the aerial photographs, will be used to assist in planning the Phase I drilling program and for defining the area of the radiation survey (see Table 7-2).

Step 2 - Radiation Survey

A radiation survey will be performed over the four Ash Pits, the Concrete Wash Pad, and the Incinerator. The radiation readings will be taken on a 10-foot grid according to the procedures described in SOP 1.16. If hotspots are detected, the size of the grid will be reduced in that area to pinpoint the radiation source. The results will be plotted and contoured on a map. The Phase I survey will be conducted using a side-shielded field instrument for detection of low energy radiation (FIDLER) and a shielded Geiger-Mueller (G-M) pancake-type detector.

Step 3 - Surface Soil Sampling and Soil Borings

Surface soil samples will be collected to a depth of 2 inches at the central location of all areas identified by the radiation survey as having above-background radiation levels. These soil samples will be collected according to the sampling procedures specified in SOP 3.8.

Borings will be drilled during the Phase I investigation to collect samples for analysis and to further characterize the pits and pads. As specified in the IAG, these borings will be placed on 25-foot centers along the long axis of each pit or pad, as identified in Step 1 (see Figure 7-3). In addition, soil borings will also be placed over hotspots detected during the radiation survey. Based on the present size of the Ash Pits, Incinerator, and Wash Pad, it is estimated that approximately 85 borings on 25-foot centers will be drilled in the area. Each boring will be drilled 5 feet into weathered bedrock and will be drilled and sampled according to procedures contained in SOP 3.2. Samples will be taken continuously in these borings. Samples will be composited from every 2-foot interval and analyzed for metals, total uranium, gross alpha, and gross beta (see subsection 7.3).

During sampling a soil classification survey will be completed at the Ash Pits for use in the Environmental Evaluation. Several samples may also be collected form 0 to 2 feet for grain size analysis.

Step 4 - Monitoring Wells

Three monitoring wells will be installed downgradient of the Ash Pits between IHSS 133 and Woman Creek (Figure 7-3). Locations for the wells will be selected following the Step 3 activities and after a review of the geologic characteristics of the site. The locations will be proposed to the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) prior to well installation. The wells will be drilled according to SOP 3.2, installed according to SOP 3.6, and developed according to SOP 2.2. The wells will be screened to monitor the saturated section of the alluvium. Following development, the wells will be sampled according to SOP 2.5 and 2.6. The Phase I analytical program for samples collected from these wells is contained in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. The wells will be sampled quarterly for one year.

7.2.3 IHSS - 142.10-11 - C-Series Detention Ponds

Step 1 - Review of Existing Data

Surface water and sediment samples are currently being collected at locations in the Woman Creek drainage as part of ongoing monitoring activities at the Rocky Flats Plant. The sampling locations, methodology, analytical parameters, and results from this monitoring will be reviewed prior to the Phase I field investigation to assess the potential overlap between the programs. Data collected during the ongoing monitoring may satisfy the requirements of this OU5 program and will be utilized, if appropriate (Table 7-3). Also, as specified in the IAG, the 1986 report "Trends in the Rocky Flats Surface Water Monitoring" (U.S. DOE 1986a) and other data pertaining to these ponds will be submitted to the EPA and the CDH.

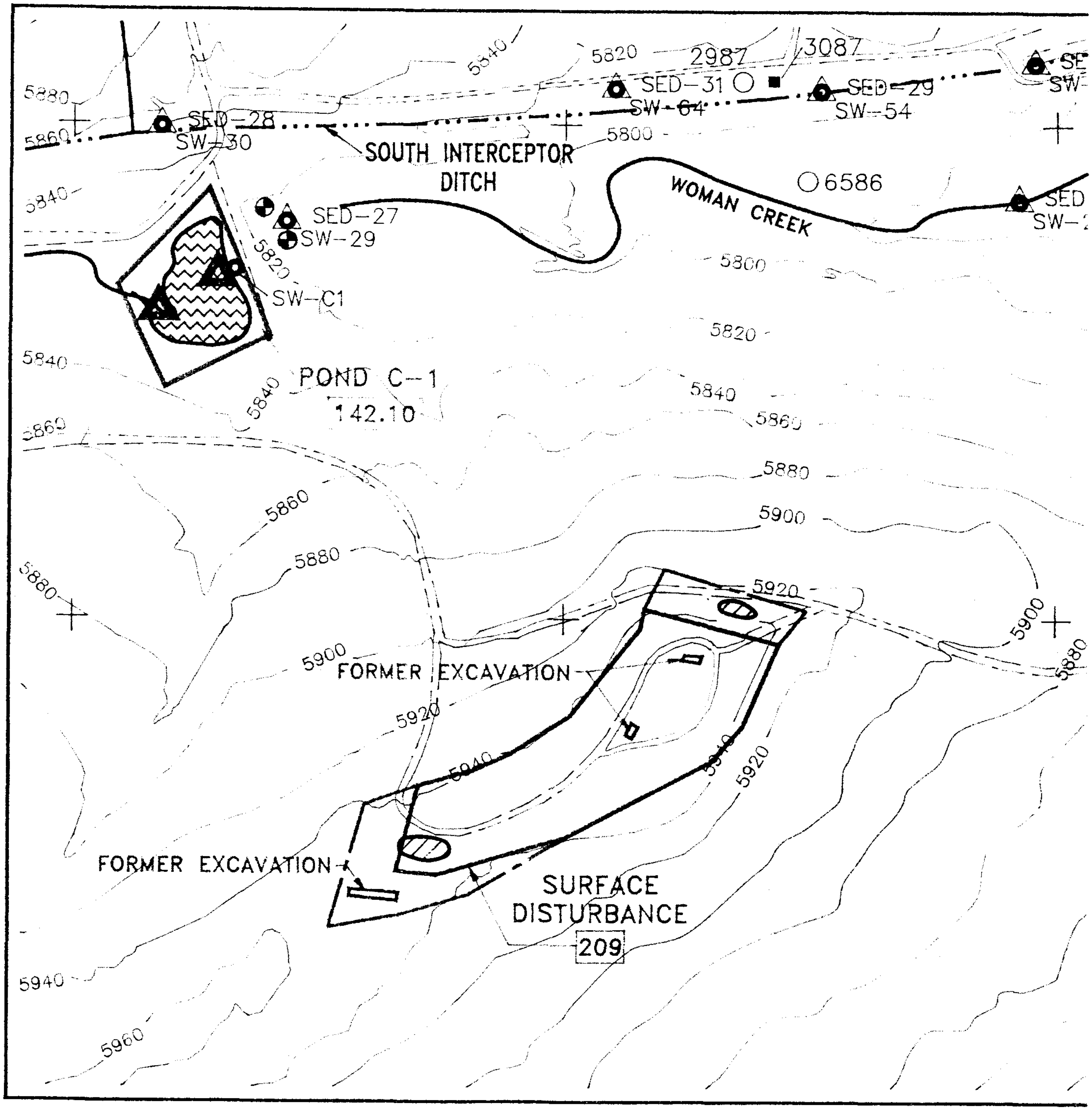
Step 2 - Surface Water and Sediment Samples

Five surface water samples will be collected from each of the two C-Series Detention Ponds. At least one of the five water samples at each pond will be taken from the deepest part of the pond. As specified in the IAG, during the collection of this sample, the presence of stratification in the pond water will be evaluated. Stratification of the water column will be identified through temperature and/or dissolved oxygen measurements taken according to SOP 4.8. If stratification of the pond is identified at this location, grab water samples will be taken from each vertically stratified zone. The second surface water sample from each pond will be collected within 5 feet of the inlet to the pond. The third surface water sample for each pond will be collected within 5 feet of the pond spillway. The two remaining sampling locations will be selected at random based on the size of the pond at the time of sample collection. The surface water sample collected at each location will consist of a composite sample from the entire vertical water column, except for the grab samples at the deepest sampling location (described above). Samples will be collected according to SOPs 4.1, 4.2, and 4.8 as they apply to pond water sampling.

Five sediment samples will be collected from each of the two C-Series Detention Ponds (Figure 7-4). One of the five sediment samples will be taken within the pond 5 feet from the inlet. A second sediment sample will be collected from the deepest part of each pond. The other three samples will be taken from random locations within the pond as it exists at the time of sampling. All sediment samples will represent the entire vertical column of sediment present at each location. If the sediment depth is greater than 2 feet, 2-foot composite samples will be collected. Sediment samples will be geologically logged according to SOP 3.1.

In addition to the above samples, grab sediment samples will be collected from discrete vertical intervals in the sediment core taken from the deepest part of the pond. These sediment samples will consist of composite samples collected at 5-centimeter intervals in this core. Each of these samples will be analyzed by a gamma radiation scan.

Sediment samples will also be collected along Woman Creek from the Concrete Wash Pad (IHSS 133.6) to Indiana Street and along the SID (Figure 7-2). Two sediment samples will be collected in the ditch running from Woman Creek to Mower Reservoir. These sediment samples will be collected within the creek or ditch at points that are conducive to the collection of sediment. The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. If the sediment is thicker than two feet then additional two-foot composite samples will be collected. The following tabulation provides the number of samples that will be collected from several sections of Woman Creek and the SID. The sediment samples from each of these segments will be collected at approximately evenly spaced intervals.



SED-28
SW-30
SOUTH INTERCEPTOR DITCH
SED-31
SW-64
SED-29
SW-54
2987
3087
6586
WOMAN CREEK
SED-27
SW-29
SW-C1
POND C-1
142.10
FORMER EXCAVATION
FORMER EXCAVATION
SURFACE DISTURBANCE
209
5800
5820
5840
5860
5880
5900
5920
5940
5960

25060120

Interval	Number of Sediment Samples
Woman Creek between the Concrete Wash Pad and Pond C-1	10
Woman Creek between Pond C-1 and C-2	4
SID between the Original Landfill and Pond C-2	10
Woman Creek between Pond C-2 and Indiana Street	2
Ditch to Mower Reservoir between Pond C-2 and Indiana Street	2

The approximate locations for the above sediment samples are shown in Figure 7-2.

All sediment samples listed above will be collected according to SOP 4.6 and the SOP Addendum (SOPA) to SOP 4.6 in Section 11.0 of this document. The chemical analyses that will be performed on these samples is presented in subsection 7.3. Only one-half of the sediment samples will be analyzed for pesticides/PCBs.

In addition to the sampling within OU5, four sediment and surface water samples will be collected west of OU5 to provide background information on Woman Creek. One sediment and surface water sample will be collected in Woman Creek adjacent to its crossing of the South Boulder Diversion Canal. Two sediment and surface water samples will be collected west of Highway 93 and the fourth sediment and surface water sample will be collected in the ditch connecting Rocky Flats Lake with Woman Creek. The samples will be collected according to SOPs 4.1, 4.2, 4.3, and 4.6. The background water samples will be collected quarterly for one year.

Step 3 - Monitoring Wells

Two monitoring wells will be installed immediately downgradient of each dam at Detention Ponds C-1 and C-2, thus providing a total of four monitoring wells in this area (Figure 7-4). The wells will be constructed within the original stream channel according to SOP 3.6 and will monitor the saturated alluvium. Following development of the wells according to SOP 2.2, the wells will be sampled according to SOPs 2.5 and 2.6. Results of the first round of well sampling will be reported in the Phase I RI Report. These wells will be sampled quarterly for one year. The chemical analyses that will be performed on these samples are discussed in subsection 7.3.

7.2.4 IHSS 209 - Surface Disturbance Southeast of Building 881 and Other Surface Disturbances

There are two surface disturbances that will be evaluated during the Phase I investigation: IHSS 209 and a surface disturbance south of the Ash Pits (Figures 7-3 and 7-4). The Phase I field sampling programs for these areas are similar and are described below. Table 7-4 summarizes the proposed program for these areas.

Step 1 - Review Aerial Photographs

Available aerial photographs, including those from 1964, 1969, 1971, and 1983, will be reviewed to evaluate the nature and use of IHSS 209 and the surface disturbance south of the Ash Pits (see Table 7-4). These photos will help to determine if there are any specific areas within each of these surface disturbances that should be investigated more fully. In addition, the feature that appears to be a pond at IHSS 209 in a 1983 aerial photo will be evaluated.

Step 2 - Visual Inspection and Radiation Survey

A visual inspection will be conducted over both of the surface disturbances to identify any stained soil and anomalous surface areas. A FIDLER radiation survey will also be performed at both areas according to SOP 1.16. This survey will be conducted randomly over each surface disturbance. If hotspots are detected, the survey will be adjusted to pinpoint the radiation source. The results of the surveys will be plotted on a map and contoured, if appropriate. The radiation surveys will be conducted using a side-shielded FIDLER and a shielded G-M pancake-type detector. If appropriate, the Step 3 field sampling program will be adjusted to investigate anomalies identified from the Step 2 visual inspection and radiation survey.

Step 3 - Soil, Surface Water, and Sediment Samples

A sediment sample and surface water sample (if present) will be collected from the deepest part of both pond-like depressions at IHSS 209 according to SOPs 4.1, 4.2, 4.3, and 4.6 (Figure 7-4). Also, a grab sample of soil will be collected from the surface to a depth of 6 inches in each of the three small excavations at IHSS 209 according to SOP 3.8.

At the surface disturbance south of the Ash Pits, two soil borings will be drilled in each of the parallel excavations, one in the east excavation area, and four in the west excavation area, resulting in a total of nine borings (Figure 7-3). The borings will be drilled to a depth of 12 feet and will be drilled and sampled according to SOP 3.2. The borings will be logged according to SOP 3.1. Samples will be taken continuously. Discrete samples will be collected from every 2-foot increment and analyzed for the TCL for volatile and semivolatile organic compounds. Samples will be composited from every 6-foot interval and analyzed for the TAL for metals and radionuclides. One surface soil sample will be collected in the north-south excavation (Figure 7-3). In addition, surface soil samples will be collected at any radiation hotspots or stained areas identified from the visual inspection and radiation survey. The analytical program for these soil and water samples is presented in the following section.

During sampling a soil classification survey will be completed at the Surface Disturbances for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

7.3 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected from the Phase I investigation. In this section, sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation requirements will be discussed.

7.3.1 Sample Designations

All sample designations generated for this RFI/RI will conform to the input requirements of the Rocky Flats Environmental Database System (RFEDS). Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sampled (e.g., "SB" for soil borings, "SS" for stream sediments), a unique five-digit number, and a two-letter suffix identifying the contractor (e.g., "WC" for Woodward-Clyde). One sample number will be required for each sample generated, including Quality Assurance (QA)/Quality Control (QC) samples. In this manner, 99,999 unique sample numbers are available for each contractor that contributes sample data to the database. A block of numbers will be reserved for the Phase I RFI/RI sampling of OU5. Boring numbers will be developed independently of the sample numbers from a boring. Specific sample location numbers are not assigned at this time, pending the results of the aerial photograph analysis and review of existing data.

7.3.2 Analytical Requirements

Generally, samples collected during the Phase I RI will be analyzed for some or all of the following chemical and radionuclide parameters:

- Nitrate
- TAL metals
- Uranium 233/234, 235, and 238
- Transuranic elements (plutonium and americium)
- Cesium 137 and strontium 89/90
- Gross alpha and gross beta

- Tritium
- Total dissolved chromium (water only)
- Beryllium
- TCL volatile organics
- TCL semivolatile organics
- Total organic carbon (TOC)
- TCL pesticides/PCBs
- CO_3, HCO_3, Cl, SO_4, NO_3 (water only)

The specific analytes in the groups listed above and their detection/quantitation limits are contained in Table 7-5. The specific Phase I analytical programs for each IHSS are contained in Table 7-6. Both filtered and unfiltered surface water and groundwater samples will be analyzed at each location.

The analytical program for each media at every IHSS is summarized in Table 7-6. The analytical program for each IHSS was developed in the IAG based on the type of waste suspected to be present at each site. The specific analytes and detection/quantitation limits are specified in the IAG by referenceto CLP (Contract Laboratory Program) analyses. The General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G 1990f) provides a listing of CLP analytes and limits that will be used for this Phase I RFI/RI. These analytes and limits are presented in Table 7-5. The program shown in Table 7-6 should address the bulk of chemicals and compounds that were handled or are suspected to be present at OU5 and enable detection of soil, sediment, surface water, and groundwater contamination, if present.

Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present in Woman Creek or the SID. Metals were probably disposed of at OU5; however, details are not well known. Therefore, all of the TAL metals have been selected for Phase I analysis.

Uranium is likely to have been a constituent of the wastes at OU5. The isotopes U-233, U-234, U-235, and U-238 have been selected for analysis in Phase I. Plutonium is the only transuranic element that is used on the site. However, americium is a daughter product of plutonium and is found at the Rocky Flats Plant. Therefore, plutonium and americium have also been selected as Phase I radionuclide parameters. Gross alpha and gross beta are included as screening parameters because they are useful indicators of radionuclides. Tritium, strontium, and cesium are also included in the analytical program.

Volatile and semivolatile organics may have been handled at OU5 in small quantities. The specific compounds used are unknown; therefore, all of the TCL volatile and semivolatile organics will be included in the Phase I analyses. TCL pesticides/PCBs and TOC have been included to provide data for the environmental evaluation.

TABLE 7-5

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	DETECTION LIMITS*	
TARGET ANALYTE LIST - METALS	Water (µg/l)	Soil/Sediment (mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Cesium	1000	200
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Lithium	100	20
Magnesium	5000	2000
Manganese	15	3.0
Mercury	0.2	0.2
Molybdenum	200	40
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Strontium	200	40
Thallium	10	2.0
Tin	200	40
Vanadium	50	10.0
Zinc	20	4.0
TOTAL ORGANIC CARBON	1	1
	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - VOLATILES	Water (µg/l)	Soil/Sediment (µg/kg)
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5

TABLE 7-5
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUNDS LIST - VOLATILES (Continued)	QUANTITATION LIMITS* Water (μg/l)	Soil/Sediment (μg/kg)
total 1,2-Dichloroethene	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,1,2,2-Tetrachloroethane	5	5
1,2-Dichloropropane	5	5
trans-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
cis-1,3-Dichloropropene	5	5
Bromoform	5	5
2-Hexanone	10	10
4-Methyl-2-pentanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Total Xylenes		

TARGET COMPOUNDS LIST - SEMIVOLATILES	QUANTITATION LIMITS* Water (μg/l)	Soil/Sediment (μg/kg)
Phenol	10	330
bis(2-Chloroethyl)ether	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitroso-di-n-dipropylamine	10	330
Hexachloroethane	10	330

TABLE 7-5
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	QUANTITATION LIMITS* Water (µg/l)	Soil/Sediment (µg/kg)
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol(para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine	10	330
4-Bromophenyl Phenylether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butylbenzylphthalate	10	330

TABLE 7-5
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	Water (µg/l)	Soil/Sediment (µg/kg)
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(2-Ethylhexyl)phthalate	10	330
Di-n-octylphthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

TARGET COMPOUND LIST - PESTICIDES/PCBS	QUANTITATION LIMITS*	
	Water µg/l	Soil/Sediment µg/kg
alpha-BHC	0.05	8.0
beta-BHC	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC (Lindane)	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor epoxide	0.05	8.0
Endosulfan I	0.05	8.0
Dieldrin	0.10	16.0
4,4'-DDD	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
4,4'-DDD	0.10	16.0
Endosulfan sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Methoxychlor	0.5	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.5	80.0
gamma-Chlordane	0.5	80.0
Toxaphene	1.0	160.0
Aroclor-1016	0.5	80.0
Aroclor-1221	0.5	80.0
Aroclor-1232	0.5	80.0
Aroclor-1242	0.5	80.0
Aroclor-1248	0.5	80.0
Aroclor-1254	1.0	160.0
Aroclor-1260	1.0	160.0

TABLE 7-5
(Concluded)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	REQUIRED DETECTION LIMITS*	
RADIONUCLIDES	Water (pCi/ℓ)	Soil/Sediment (pCi/g)
Gross Alpha	2	4 dry
Gross Beta	4	10 dry
Uranium 233+234, 235, and 238 (each species)	0.6	0.3 dry
Americium 241	0.01	0.02 dry
Plutonium 239+240	0.01	0.03 dry
Tritium	400	400 (pCi/ml)
Cesium 137	1	0.1 dry
Strontium 89+90	1	1 dry

	DETECTION LIMITS*
Parameters Exclusively for Groundwater Samples	Water (mg/ℓ)
ANIONS	
Carbonate	10
Bicarbonate	10
Chloride	5
Sulfate	5
Nitrate as N	5
FIELD PARAMETERS	
pH	0.1 pH unit
Specific Conductance	1
Temperature	
Dissolved Oxygen	0.5
Barometric Pressure	
INDICATORS	
Total Dissolved Solids	5

* Detection and quantitation limits are highly matrix dependent. The limits listed here are the minimum achievable under ideal conditions. Actual limits may be higher.

TABLE 7-6

PHASE I ANALYTICAL PROGRAM

IHSS	Location	Media	Total U	Total Cr	Be	H3	Nitrate	Gross α	Gross β	U 233/234	U 235	U 238	Pu 239/240	Am 241	Cs 137	Sr 89/90
115	Borings to confirm soil gas	Soil														
	Borings transecting plumes grabs from 2' intervals 6' composites	Soil Soil			X					X	X	X	X	X	X	X
	Wells downgradient of unit	Water	X		X								X	X		
	Effluent from pipes	Water	X		X								X	X		
	Sediments in SID and Woman Creek	Seds.	X		X								X	X		
	Water in SID and Woman Creek	Water	X		X								X	X		
133	Borings on 25' centers	Soil	X					X	X							
	Surface samples on 25' centers	Soil	X					X	X							
	Wells downgradient of unit	Water	X		X								X	X		
142	Sediment samples in Woman Creek and SID	Seds.		X	X	X	X	X	X	X	X	X	X	X	X	X
	Water samples from ponds	Water		X	X	X	X	X	X	X	X	X	X	X	X	X
	Wells downgradient of C-1 and C-2	Water		X	X	X	X	X	X	X	X	X	X	X	X	X
209	Sediment in former pond	Seds.						X	X							
	Water in former pond	Water						X	X							
	Soil in small depressions	Soil						X	X							
SD*	Borings in area	Soil						X	X							
	Surface Soils	Soil						X	X							

* Surface disturbance south of the Ash Pits.

TABLE 7-6
(Concluded)
PHASE I ANALYTICAL PROGRAM

IHSS	Location	Media	TAL Metals	TOC	TCL Vols	TCL Semi V	TCL Pest	Filtered: U	Filtered: Pu 239/240	Filtered: Cs 137	Filtered: Sr 89/90	Filtered: Am 241	Filtered: Pb	Filtered: Total Cr	Filtered: TAL Metals	Filtered: Be	Filtered: Anions TDS
116	Borings to confirm soil gas	Soil			X												
	Borings transecting plumes grabs from 2' intervals	Soil			X	X											
	6' composites	Soil	X														
	Wells downgradient of unit	Water	X		X	X	X	X	X	X	X	X	X	X			X
	Effluent from pipes	Water	X		X	X		X	X	X	X	X	X	X			X
	Sediments in SID and Women Creek	Seds.	X		X	X		X	X	X	X	X	X	X			
	Water in SID and Woman Creek	Water	X		X	X		X	X	X	X	X	X	X			X
133	Borings on 25' centers	Soil	X														
	Surface samples on 25' centers	Soil	X	X													
	Wells downgradient of unit	Water	X		X	X		X	X	X	X	X				X	X
142	Sediment samples in Woman Creek and SID	Seds.	X	X	X	X	X										
	Water samples from ponds	Water	X		X	X		X	X	X	X	X			X	X	X
	Wells downgradient of C-1 and C-2	Water	X		X	X		X	X	X	X	X			X	X	X
209	Sediment in former pond	Seds.	X		X	X											
	Water in former pond	Water	X		X	X											
	Soil in small depressions	Soil	X	X	X	X											
SD*	Borings in area	Soil	X		X	X											
	Surface soils	Soil	X	X	X	X											

* Surface disturbance south of the Ash Pits.

The analytical parameters for the soil gas survey at IHSS 115 are 1,1,1-trichloroethane (TCA), dichloromethane, benzene, carbon tetrachloride, tetrachloroethene (PCE), and trichloroethene (TCE). Detection limits proposed for these parameters during the soil gas survey are listed in Table 7-7.

7.3.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and by the analyses to be performed. The soil matrices to be analyzed will include soils and sediments. The water matrices for analysis will include surface water and groundwater. Tables 7-8 and 7-9 list analytical parameters of interest in OU5 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times. Additional specific guidance on the appropriate use of containers and preservatives is provided in SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

7.3.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in SOP 1.14.

7.3.5 Data Reporting Requirements

Field data will be input into the RFEDS environmental database using a remote data entry module supplied by EG&G. Data will be entered on a timely basis and a 3.5-inch diskette will be delivered to EG&G. A hard copy report will be generated from the module for contractor use. The data will be put through a prescribed QC process based on Standard Operating Procedure (SOP) 1.14 to be generated by EG&G.

A sample tracking spreadsheet will be maintained by the contractor for use in tracking sample collection and shipment. EG&G will supply the spreadsheet format and will stipulate the timely reporting of the information. This data will also be delivered to EG&G on 3.5-inch diskettes.

Computer hardware and software requirements for contractors using government supplied equipment will be supplied by EG&G. Computer and data security will also follow acceptable procedures outlined by EG&G.

TABLE 7-7

PHASE I INVESTIGATION
SOIL GAS PARAMETERS AND
PROPOSED DETECTION LIMITS

IHSS-115 Original Landfill

Volatiles	Detection Limit
1,1,1 TCA	1 µg/ℓ
Dichloromethane	1 µg/ℓ
Benzene	1 µg/ℓ
Carbon Tetrachloride	1 µg/ℓ
PCE	1 µg/ℓ
TCE	1 µg/ℓ

NOTE: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary.

TABLE 7-8

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR WATER SAMPLES

Parameter	Container	Preservative	Holding Time
Liquid - Low to Medium Concentration Samples			
Organic Compounds:			
Purgeable Organics (VOCs)	2 x 40-mℓ VOA vials with teflon-lined septum lids	Cool, 4°C[a] with HCl to pH<2	7 days 14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 4-ℓ amber[b] glass bottle	Cool, 4°C[a]	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 1-ℓ polyethylene bottle	Nitric acid pH<2; Cool, 4°C	180 days[c]
Cyanide	1 x 1-ℓ polyethylene bottle	Sodium hydroxide[d] pH>12; Cool, 4°C	14 days
Anions	1 x 1-ℓ polyethylene bottles	Cool, 4°C	14 days
Sulfide	1 x 1-ℓ polyethylene bottle	1 mℓ-zinc acetate sodium hydroxide to pH>9; Cool, 4°C	7 days
Nitrate	1 x 1-ℓ polyethylene bottle	Cool, 4°C	48 hours
Total Dissolved Solids (TDS)	1 x 1-ℓ polyethylene bottle	Cool, 4°C	48 hours
Radionuclides	1 x 1-ℓ polyethylene bottle	Nitric acid pH<2;	180 days

[a] Add 0.008% sodium thiosulfate ($Na_2S_2O_3$) in the presence of residual chlorine

[b] Container requirement is for any or all of the parameters given.

[c] Holding time for mercury is 28 days.

[d] Use ascorbic acid only if the sample contains residual chlorine. Test a drop of sample with potassium iodine-starch test paper; a blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6g of ascorbic acid for each liter of sample volume.

TABLE 7-9

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR SOIL SAMPLES

Parameter	Container	Preservative	Holding Time
Soil or Sediment Samples - Low to Medium Concentration			
Organic Compounds:			
Purgeable Organics (VOCs)	1 x 4-oz wide-mouth teflon-lined glass vials	Cool, 4°C	14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 8-oz wide-mouth teflon-lined glass vials	Cool, 4°C	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 8-oz wide-mouth glass jar	Cool, 4°C	180 days[1]
Cyanide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	14 days
Sulfide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	28 days
Nitrate	1 x 8-oz wide-mouth glass jar	Cool, 4°C	48 hours
Radionuclides	1 x 1-ℓ wide-mouth glass jar	None	45 days

[1]Holding time for mercury is 28 days.

7.4 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the Environmental Restoration (ER) Project Manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their application are discussed below. The frequency for QC samples to be collected and analyzed is provided in Table 7-10.

Duplicate samples will be collected by the sampling team and will be used as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field preservation blanks of distilled water, preserved according to the preservation requirements (subsection 7.3.3), will be prepared by the sampling team and will be used to provide an indication of any contamination introduced during field sample preparation technique. As indicated by Table 7-10, these QC samples are applicable only to samples requiring chemical preservation. Equipment (rinsate) blanks will be collected from a final decontamination rinse to evaluate the success of the field sampling team's decontamination efforts on nondedicated sampling equipment.

Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection. The rinsate is collected and placed in the appropriate sample container. Equipment rinsate blanks are applicable to all analyses for water and soil samples as indicated in Table 7-10.

Trip blanks consisting of deionized water will be prepared by the laboratory technician and will accompany each shipment of water samples for volatile organic analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of volatile organics or problems associated with the shipment, handling, or storage of the samples.

Procedures for monitoring field QC are given in the site-wide Quality Assurance Project Plan (QAPjP).

TABLE 7-10

FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Media	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Preservation Blanks	Organics	NA	NA
	Inorganics	NA	1/20
	Radionuclides	NA	1/20
Equipment Rinsate Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks	Organics (Volatiles)	NR	1/20
	Inorganics	NR	NR
	Radionuclides	NR	NR

NA = Not Applicable
NR = Not Required

8.1 OVERVIEW

A baseline health risk assessment will be prepared for Operable Unit Number 5 (OU5) as part of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) report. Both a human health evaluation and an environmental evaluation will be performed. This section describes the human health risk assessment. The environmental risk assessment is described in Section 9.0 of this Work Plan.

The purpose of the Phase I baseline risk assessment is to confirm the presence or absence of contamination at OU5 and provide an estimate of potential health risks that may result from releases of hazardous substances from OU5 in the absence of any remedial action. Risks will be calculated for both on-site and off-site exposures to chemicals released and/or transported from the Individual Hazardous Substance Sites (IHSSs), using available data as well as data collected during the Phase I investigation of the unit.

The purpose of the baseline risk assessment is to provide information useful in determining the following, as described in the National Contingency Plan:

- A determination of whether the contaminants of concern identified at the site pose a current or potential risk to human health in the absence of any remedial action
- A determination of whether remedial action is necessary at IHSSs within the unit, and an identification of the exposure pathways needing remediation
- A justification for performing remedial actions

This assessment will follow the guidance provided by the Environmental Protection Agency. It will also make use of additional information and methods that will facilitate interpretation of the results of the risk assessment. EPA publications that will be consulted when performing the health risk assessment include the following:

- Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. 1989. EPA/540/1-89/002.
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. 1988.
- Superfund Exposure Assessment Manual. 1988. EPA/540/1-88/001.
- Exposure Factors Handbook. 1989. EPA/600/8-89/043.

* Guidance for Data Useability in Risk Assessment. Interim Final. 1990. EPA/540/G-90/008.

These documents constitute the most recent and appropriate EPA guidance on public health risk assessment. It must be emphasized that EPA manuals are guidelines only and that EPA states that considerable professional judgment must be used in their application. This risk assessment will focus on producing a realistic analysis of exposure and health risk.

The risk assessment will be accomplished in five general steps: identification of chemicals of concern, exposure assessment, toxicity assessment, uncertainty analysis, and risk characterization.

A separate risk assessment will be performed on each IHSS to the extent appropriate for the IHSS. Due to the separated locations, varied historical practices, and different contamination profiles, the IHSSs should receive individualized treatment. This IHSS-specific analysis will allow the identification of the most important contributors to the risk from the operable unit, and it will permit sufficient attention to be paid to contaminants that may be important at one IHSS but not at another. IHSSs that do not contribute significant risks can then be identified so that efforts may be aimed at further analysis of the significant sources of risk.

8.2 IDENTIFICATION OF CHEMICALS OF CONCERN

Chemicals of concern are a subset of all the chemicals or other constituents, such as metals or radionuclides, that are identified at the unit. They are the chemicals that are evaluated in the baseline risk assessment. A two-step process will be used to identify chemicals of concern. First, an initial list of chemicals of potential concern are selected on the basis of the following criteria:

* They are identified in one or more samples at the IHSS.
* They are related to activities at the IHSS; they are potentially released from an identified source in the IHSS.
* They are recognized or suspected toxicants or carcinogens.
* They are present in significant concentrations (above background).

Chemicals of potential concern will be selected following evaluation of available historical and background sampling results and the results of the Phase I field sampling proposed for OU5. Existing background data will be used to help identify chemicals that are background constituents in the environment and that are therefore not IHSS-related. Background information is expected to be available from ongoing studies including the "Background Geochemical Characterization Report, Rocky Flats Plant." (EG&G 1990c).

Available historical data on chemical and radionuclide concentrations in groundwater, surface water, sediments, soils and air near OU5 will be used in conjunction with the results of the Phase I field sampling program to identify IHSS-related chemicals of concern.

Existing analytical results taken from other sources will be accepted as suitable for risk assessment purposes. The sampling and analytical program for the Phase I investigation of OU5 is described in Section 7.0 of this Work Plan. The sampling program is designed to address all potential exposure pathways (groundwater, surface water, sediments, and soils) to the extent that they can be anticipated. Samples and analytical results obtained as part of the Phase I investigation will be collected and validated according to the Quality Assurance (QA)/Quality Control (QC) procedures described in that section. Only data validated as suitable for risk assessment purposes will be used in the risk assessment.

Tentatively Identified Compounds (TICs) will be evaluated to determine if they should be included in the risk assessment. If there are few of them in comparison to the Target Analyte List (TAL), they are normally omitted in accordance with EPA guidance.

The second step in the identification process will be followed if the number of chemicals of potential concern is high. In that case, the list may be further reduced to focus on the chemicals that pose the greatest risks at the site. Carrying a very large number of chemicals through a quantitative risk assessment can be unwieldy, time-consuming, and may obscure the dominant risks at the site. The rationale for selecting a final list of chemicals of concern will be presented in the text and will be based on the following criteria:

- historical information
- concentration and toxicity
- mobility, persistence, and bioaccumulation
- special exposure routes
- treatability
- Applicable or Relevant and Appropriate Requirements (ARARs)
- chemical class
- frequency of detection (hits/samples)
- evaluation of essential nutrients
- concentration relative to background levels (natural or anthropogenic)
- potential for being a laboratory contaminant

The results of data collection and evaluation and selection of chemicals of concern will be summarized in the text and appropriate tables.

8.3 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to identify human populations (receptors) that might be exposed to chemical releases from the IHSSs and to estimate the temporal variation and magnitude of their exposure. The exposure assessment involves identifying potential receptors, identifying all potential pathways of exposure, estimating exposure point concentrations of chemicals of concern based on monitoring data and modeling results, and estimating the intake of each chemical for each pathway. The results of the exposure assessment are pathway-specific chemical intakes, expressed as mg chemical/kg body weight/day, by potentially exposed receptor populations. Exposure to radioisotopes will be expressed as activity of intake for internal exposure or as activity in environmental media for external exposure.

Conceptual models of the IHSSs will be formulated and refined based on data collected to integrate the components of the exposure assessment and clarify the pathways to be considered.

8.3.1 Potential Receptors

The exposure scenarios that will be developed in the baseline risk assessment may include exposure of potential future receptors to contaminated media within OU5 as well as exposure of off-site receptors to potentially contaminated groundwater, surface water, and airborne soil particulates. The exact exposure scenarios to be considered will be selected according to policy decisions regarding future use (*e.g., residential, recreational, restricted access*) of the site that may be made prior to the completion of the risk assessment.

8.3.2 Exposure Pathways

Identification of exposure pathways involves linking the source of chemical release, an environmental transport mechanism, a point of human exposure, and a mechanism of human uptake. Sources of chemical release will be sites within OU5 that contain chemicals of concern significantly above background levels. Mechanisms of release can include leaching of chemicals from soils into groundwater or surface runoff, airborne transport of contaminated soil particulates, volatilization of organic compounds, or release of radioactive particles. Points of human exposure will be identified during the site characterization. These may include sites within the operating unit as well as off-site locations where contaminants may be transported. Examples of mechanisms of human uptake are dermal contact with contaminated media, inhalation of volatile organics or particulates, and ingestion of soils or water.

Only complete exposure pathways will be evaluated in the risk assessment. If any one of the elements of an exposure pathway (chemical source and release, environmental transport mechanism, exposure point, or uptake) is missing, the exposure pathway is considered incomplete and will not be addressed in the assessment.

8.3.3 Exposure Point Concentrations

Exposure point concentrations of chemicals of concern will be estimated using analytical results of the sample program described elsewhere in this Work Plan and available relevant historical data. Release and transport of chemicals in environmental media may be modeled using basic analytical models recommended by EPA or the best model available, as determined by a model performance evaluation. The models will be calibrated to improve performance using site-specific parameters when possible.

Model outputs will be characterized by estimating variance through an uncertainty analysis to the extent required by the overall risk uncertainty analysis. Effort will be made to reduce the variance of model output: the optimal target for model variance is that it be similar to other sources of variability in the risk assessment, including exposure factors and toxicity values.

Concentrations will also be estimated for "average" and "reasonable maximum" exposure conditions at a minimum. When feasible, a goodness-of-fit analysis will be conducted to correctly identify the distribution of the data and the most appropriate measure of central tendency. The reasonable maximum concentration will be the upper 95 percent confidence limit on the appropriate mean or maximum likelihood estimate. In calculating the media concentrations, censored data (data sets with missing values, nondetects, etc.) will be treated by appropriate methods such as those described in Gilbert, 1987 (Statistical methods for environmental pollution monitoring, Van Nostrand Reinhold).

8.3.4 Estimation of Intake

Human intakes of chemicals of concern will be estimated using reasonable estimates of exposure parameters. EPA guidance, site-specific factors, and professional judgment will be applied in establishing exposure assumptions. Using reasonable values permits estimating risks associated with the assumed exposure conditions that do not underestimate actual risk. The estimate of intake is the "intake factor," which may then be mathematically combined with the exposure point concentrations and the critical toxicity values to determine cancer risks and hazard indices.

8.4 TOXICITY ASSESSMENT

The toxicity assessment is conducted to characterize the evidence regarding the potential for a chemical of concern to cause adverse effects in exposed populations and, where possible, to estimate the relationship between the extent of exposure and the extent of adverse effects (i.e., dose-response relationship). The toxicity assessment evaluates:

- The evidence for toxic effects of the chemical
- The nature of the dose-response relationship
- The level of uncertainty in the dose-response relationship
- The primary target organs or mechanism of action for each compound of concern
- The applicability of the toxicologic data to the identified exposure scenarios

Sources of toxicity factors (cancer slope factors and reference doses) used in assessing health risks due to exposure to organic compounds, metals, and radionuclides include EPA's Integrated Risk Information System (IRIS) and the most current volume of EPA's Health Effects Assessment Summary Tables. Other sources in the public domain, such as the National Research Council's reports on the Biological Effects of Ionizing Radiation, reports IV and V, and EPA's Background Information Document, Draft E/S for Proposed National Emission Standards for Hazardous Air Pollutants (NESHAPS) for Radionuclides, will be consulted as appropriate. New toxicity data and analyses of the health risks of contaminants of concern will be considered as they become available in the literature. No new experimental toxicological data will be developed.

The toxicity assessment will include a discussion of the uncertainties inherent in the development and application of toxicity factors. The text will include a discussion of the EPA weight-of-evidence classification for carcinogens, the conservatism inherent in applying upper 95th percentile cancer slope factors, the uncertainty factors used in deriving reference doses, and other uncertainties involved in predicting human responses.

In addition, those chemicals that present the greatest risk at the site will receive additional toxicological analysis to more fully describe the potential range of appropriate critical toxicity values based on such considerations as mechanism of carcinogenesis, the validity of toxicity endpoints used to derive the RfD, or pharmakokinetic information that may provide insight on extrapolation from one species to another.

8.5 QUALITATIVE AND QUANTITATIVE UNCERTAINTY ANALYSIS

Presentation of uncertainties and limitations of the risk analysis is an integral part of the risk assessment process. Usually, uncertainty is discussed after the risk characterization has been completed. However, in this risk assessment, the uncertainty analysis will provide substantial input into the risk characterization process.

Uncertainties exist primarily in the estimation and modeling of exposure point concentrations, the estimation of human exposures, and the use of toxicology data based on animal studies. These uncertainties will be described qualitatively to provide an understanding of the issues. In addition, a detailed quantitative analysis of the uncertainty will be presented to the extent practicable.

Several methods are available for quantitative analysis. The uncertainty analysis will be performed to quantify, to the extent practicable, the sources and magnitude of uncertainty in the baseline risk assessment. Quantitative techniques may include: sensitivity analysis, first-order analysis, or numerical methods such as stratified Monte Carlo sampling. The outputs will be described and interpreted in the text. This will inform the risk manager of the sufficiency of the baseline risk assessment given the level of site characterization at the conclusion of Phase I, the degree of confidence that is appropriate for the risk estimates, and a basis for further remedial activities at the site.

8.6 RISK CHARACTERIZATION

Risk characterization integrates the toxicity factors for the chemicals of concern with the estimated chemical intakes and radiation exposures under the assumed exposure conditions to yield protective estimates of carcinogenic and noncarcinogenic health risks. The IHSS conceptual models will be consulted again at this point to determine realistic combinations of exposure pathways as well as maximum likelihood/reasonable maximum estimates for those pathways. Risks to receptors associated with different chemicals and exposure routes will be summed across exposure pathways that are likely to occur simultaneously in order to estimate total noncarcinogenic and carcinogenic risk from chemicals and radioisotopes. When toxicants with known mechanism of action or target organ specificity in humans can be identified, their hazards will be segregated and considered separately.

The results of the risk characterization for average, reasonable maximum, and reasonable minimum exposure conditions as determined by the uncertainty analysis will be summarized in tables and discussed in the text. The risk characterization will therefore be an unbiased estimate of risks upon which risk management decisions may be based. Populations that may be affected by the real or potential risks will be identified to the extent that is possible. These results will be discussed in the context of the output from the uncertainty analysis described above. This information will allow the risk manager to make a more informed decision on a final deterministic cleanup value.

9.1 INTRODUCTION

The objective of this Environmental Evaluation Plan is to provide a framework for addressing risks to the environment from potential exposure to contaminants resulting from IHSSs within the Woman Creek Drainage, OU5. This plan is prepared in conformance with the requirements of current applicable legislation, including the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and follows the guidance for such studies as provided in the National Contingency Plan (NCP) and Environmental Protection Agency (EPA) documents for the conduct of Resource Conservation and Recovery Act (RCRA) Facility Investigation/ Remedial Investigation (RFI/RI) activities. Specifically, the EPA guidance provided in Risk Assessment Guidance for Superfund, Vol. II, Environmental Evaluation Manual (U.S. EPA 1989c) is followed.

The goal of the environmental evaluation is to determine the nature and extent of potential impacts of contamination from OU5 to biota (plants, animals and microorganisms). Determination of the effects on biota will be performed in conjunction with the human health risk assessment for OU5. Where appropriate, criteria necessary for performing the environmental evaluation will be developed in conjunction with human health risk assessments and environmental evaluations for all Rocky Flats Plant OUs. Information from the environmental evaluation will assist in determining the form, feasibility, and extent of remediation necessary for Woman Creek Drainage in accordance with CERCLA.

During preparation of this work plan, several documents were reviewed as part of an assessment of available information. These included the Final Environmental Impact Statement (EIS), Rocky Flats Plant (U.S. DOE 1980); Wetlands Assessment (EG&G 1990g); Draft Environmental Evaluation Work Plan for OU2 (in RFI/RI Work Plan, EG&G 1991d); Final OU1 Environmental Assessment (U.S. DOE 1990c); and the Final Phase III RFI/RI Work Plan, 881 Hillside Area (U.S. DOE 1990d) among others. Literature reviews will continue throughout the environmental evaluation. Review of this Draft Phase I RFI/RI Work Plan for OU5 and the Environmental Evaluation Work Plans for OU1 (U.S. DOE 1990d) and OU2 (EG&G 1991d) formed the basis for the establishment of the initial sampling locations presented in the OU5 Field Sampling Plan (Subsection 9.3).

9.1.1 Approach

This plan presents a comprehensive approach to conducting the environmental evaluation at Woman Creek Drainage. This comprehensive approach is designed to ensure that all procedures to be performed are appropriate, necessary and sufficient to adequately characterize the nature and extent of environmental effects to biota under the "no action" scenario. As is recommended by EPA, this environmental evaluation is not intended to be or to develop into a research-oriented project. The plan presented herein is designed to provide a focused investigation of potential contaminant effects on biota.

Each task of the environmental evaluation will be coordinated with RFI/RI activities at nearby operable units in order to avoid unnecessary duplication of effort and resources. Environmental evaluation planning is currently underway at two operable units in close proximity to OU5: OU1 (881 Hillside) and OU2 (903 Pad, Mound, and East Trenches Area). A coordinated approach with these operable units is necessary in order to account for contaminant migration into OU5.

The environmental evaluation process has been divided into ten tasks. These tasks and their interrelationships are shown on Figure 9-1. The following is a brief description of each of these tasks. More detailed descriptions of each task are presented in Subsection 9.2.

Task 1: Preliminary Planning

Task 1 will focus on planning and coordination of the OU5 environmental evaluation with OU5 RFI/RI and Human Risk Assessment activities and with nearby OU1 and OU2 activities. Task 1 will include a determination of the scope of work and a definition of the study area. Data Quality Objectives (DQO) will be defined in Task 1 according to EPA guidance (U.S. EPA 1989d), and procedures for monitoring and controlling data quality will be specified. Task 1 activities will also include development of criteria for selection of.contaminants of concern, key receptor species, and reference areas.

Task 2: Data Collection/Evaluation and Preliminary Risk Assessment

Task 2 will include a review, evaluation, and summary of available chemical and ecological data and identification of data gaps. Based on these data, a preliminary ecological risk assessment will be performed to identify contaminants of concern and their documented effects on key receptor species and/or other ecological endpoints. As part of this preliminary risk assessment, a food web model will be developed and preliminary exposure pathways will be identified. Results of this tasks will be used to refine the ecological and ecotoxicological field investigation sampling designs.

Task 3: Ecological Field Investigation

Task 3 will include the preliminary field surveys and an ecological field inventory to characterize OU5 biota and their trophic relationships and to note locations of obvious zones of chemical contamination. Brief field surveys will be conducted in the spring, summer, fall, and winter to obtain information on the occurrence, distribution, variability, and general abundance of key plant and animal species. Field inventories will be conducted in late spring and summer to obtain quantitative data on community composition in terrestrial and aquatic habitats. Samples collected as part of the activity will be saved for tissue analyses where contaminants of concern have been identified and sampling protocol are in place. Task 3 will also include aquatic toxicity tests using Ceriodaphnia spp and fathead minnows. As part of these activities, all collected field data will be reduced, evaluated, compared with and integrated into the existing data bank to update knowledge of site conditions.

Task 4: Toxicity Assessment

Task 4 will entail compilation of toxicity literature and the toxicological assessment of potential adverse effects from contaminants of concern on key receptor species. This task will be performed in conjunction with the following Task 5.

Task 5: Exposure Assessment and Pathways Model

Task 5 will entail development of a site-specific pathways model based on the ecological field investigation and inventory. This exposure-receptor pathways model will be used to evaluate the transport of contaminants at OU5 to biological receptors. The pathways model is based on a conceptual pathways approach (Fordham and Reagan 1991) and will provide an initial determination of the movement and distribution of contaminants, likely interactions among ecosystem components and expected ecological effects. It is anticipated that this approach will be coordinated with the efforts of investigators working in other operable units to avoid duplication of effort, to collect comparable data and to provide a consistent assessment of environmental risk.

Task 6: Preliminary Contamination Characterization

Task 6 will provide a characterization of the risk or threat of OU5 contaminants to receptor populations and habitats and a summary of risk-related data concerning the site. Determinations will be made as to the magnitude of the effects of contamination on OU5 biota. The actual or potential effects of contamination on ecological endpoints (e.g., species diversity, food web structure, productivity) will also be addressed. Depending on the DQOs and the quality of data collected, the contamination characterization will be expressed qualitatively, quantitatively, or a combination of the two. Task 6 may include the preliminary derivation of remediation criteria. Development of these criteria will entail consideration of federal and Colorado laws and regulations pertaining to preservation and protection of natural resources that are Applicable or Relevant and Appropriate Requirements (ARARs) (see Section 3.0). Information from ARARs, toxicological assessments and the pathways model will be used to develop criteria that address biological resource protection.

Task 7: Uncertainty Analysis

Task 7 includes the identification of assumptions and the evaluation of uncertainty in the environmental risk assessment analysis. Task 7 will include the identification of data needs to calibrate/validate the pathways model developed in Task 5.

Task 8: Planning

Task 8 will entail the development of additional DQOs with respect to the conduct of the Task 9, Ecotoxicological Field Investigation. DQOs to be achieved by such sampling will be defined according to EPA guidance (U.S. EPA 1989d). Scoping and design of the Task 9 field studies will be based initially on the outcome of the Task 2 preliminary risk assessment. Field sampling will only be performed where acceptance criteria for demonstrating injury to a biological resource will be satisfied in accordance with regulations under the Natural Resource Damage Assessment Rule [40 CFR Subtitle A Section 11.62 (f)].

Task 9: Ecotoxicological Field Investigation

Task 9 will include tissue analysis studies and any additional ecotoxicological field investigations. Samples collected in Task 3 field studies will be used wherever possible (e.g., when contaminants of concern have been identified and sampling protocols are in place); new samples will be collected if necessary. The need for measuring additional population endpoints through reproductive success, enzyme inhibition, or other ecotoxicological studies will be evaluated based on the Task 3 preliminary ecological risk assessment. Selection of the target analytes, species, and tissues will be based on the determination of which contaminants are likely to be present in sufficient concentrations, quantities, and locations as to be detected in biota. All necessary federal and state permits will be obtained prior to any destructive sampling or collecting.

Task 10: Environmental Evaluation Report

Task 10 will provide a final characterization of contamination in biota at OU5. Results from the Task 9 ecotoxicological field investigations will be used to evaluate ecosystem effects. Information on site environmental characteristics and contaminants, characterization of effects, remediation criteria, conclusions, uncertainty analysis and limitations of the assessment will be summarized into the Environmental Evaluation Report.

Each of the preceding tasks is described in further detail in Subsection 9.2. A suggested outline for the Environmental Evaluation Report is presented in Subsection 9.2.11. The field sampling plan presented in Subsection 9.3 addresses both the Task 3 ecological investigation and the Task 9 ecotoxicological field investigations. A tentative outline for performing the environmental evaluation is presented in Subsection 9.4.

9.1.2 OU5 Contamination

A number of chemicals is suspected to be present in the soils and surface water at OU5 (see Table 9-1). Preliminary reviews of available data show some chemicals (organics, metals, and radionuclides) in surface water to be above *detection* levels (Tables 2-5 and 2-6). Which of these levels are above background is currently being evaluated as part of the RFI/RI effort. Most of the chemicals shown in Tables 2-5, 2-6, and 9-1 are likely to impact biota if present at sufficient concentrations. The following subsections present a discussion of which of these chemicals are likely to be of paramount concern at OU5 given their toxic nature. Actual selection of contaminants of concern to biota will take place in Task 2 after a more detailed analysis of potential adverse effects and review of available toxicological literature.

9.1.2.1 Metals

Terrestrial Ecosystems

Data on contaminant levels in soils at OU5 are not yet available as this is a Phase I RFI/RI investigation. Based on the occurrence of metal contaminants in OU5 aquatic ecosystems, contamination of terrestrial ecosystems can also be expected. Heavy metals are the most commonly evaluated environmental contaminants in biomonitoring studies of terrestrial ecosystems. Studies on heavy metals are of several types: (1) reports of metal concentrations in animals from only one location, (2) correlations of tissue concentrations with environmental concentrations, (3) monitoring a site through time, (4) concentrations in animals collected along a gradient of pollution, and (5) comparisons of concentrations in animals from reference and contaminated sites or sites where contamination is suspected. These studies generally provide information on background concentrations of contaminants and correlations of tissue concentrations with environmental concentrations. Data from the Talmage and Walton (1990) study is available for most heavy metals for a variety of mammal species and lower trophic levels.

TABLE 9-1

CHEMICALS DETECTED AT OU5

ORIGINAL LANDFILL (IHSS 115)

Soil:

Organics: petroleum distillates, 1,1,1-trichloroethane, dichloromethane, benzene, carbon tetrachloride and trichloroethane

Metals: beryllium, lead and chromium

Radionuclides: uranium

ASH PITS, INCINERATOR AND CONCRETE WASH PAD (IHSSs 133.1-133.6)

Soil:

Radionuclides: uranium
Metals: unknown

Ponds C-1 AND C-2 (IHSSs 142.10 and 142.11)

Surface Water:

Organics: phenol, di-n-butyl phthalate

Metals: manganese, zinc, aluminum, mercury and strontium

Radionuclides: americium-241, cesium-137, plutonium-239, strontium-90, tritium, uranium-233/234, uranium 235, uranium-238 and radium-226

Anions: sulfide/sulfate and nitrate/nitrite

Sediments:

data on metals, organics and anions not yet available

Radionuclides: plutonium

WOMAN CREEK DRAINAGE

Surface Water:

Organics: data not yet available

Metals: aluminum, strontium, manganese, barium, lead, lithium, zinc, mercury, molybdenum, chromium, copper, tin, arsenic, beryllium, cobalt and nickel

Radionuclides: americium-241, cesium-137, plutonium-239, strontium-90, uranium-233/234, uranium-235, uranium-238, tritium and radium-226

Anions: sulfate and nitrate/nitrite

Sediments:

Data not yet available

Several of the heavy metals detected in aquatic ecosystems at OU5 are phytotoxic and are known to bioaccumulate and biomagnify in terrestrial ecosystems. Bioaccumulation, the process by which chemicals are taken up by organisms directly or through consumption of food containing the chemicals, is documented for arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, and selenium. Biomagnification, or the process by which tissue concentrations of chemicals increase as the chemical passes up through two or more trophic levels, is documented from soil to plants for beryllium, cadmium, chromium, copper, lead, mercury, and selenium. In herbivores, biomagnification occurs for antimony, arsenic, cadmium, chromium, copper, lead, mercury and selenium. In terrestrial carnivores, mercury and cadmium are known to biomagnify. Depending on historical usage, concentrations detected in soils, and the biological receptors at OU5, any, if not all, of these metals are likely to become contaminants of concern in the OU5 environmental evaluation.

Aquatic Ecosystems

EPA has established ambient water quality criteria (AWQC) to be protective of the environment (U.S. EPA 1986b). Specifically, the criteria were established to be protective of all aquatic life forms. One rationale for establishing criteria protective of aquatic life is that aquatic organisms and plants are important in food chains to higher life forms. In addition, their direct dependence on the aquatic environment results in constant contact with the water and the organisms are therefore likely to assimilate any contaminants. One EPA objective in establishing AWQC was to determine chemical concentrations that would not be directly harmful to aquatic organisms and plants and would not present a hazard to higher life forms due to any biomagnification of individual chemical substances.

Of the metals detected in surface water at OU5, eight are of immediate interest in the evaluation of aquatic ecosystems given their presence at levels above Federal surface water quality standards (Table 9-2). These are aluminum, barium, chromium, copper, lead, manganese, mercury, and zinc. Of the heavy metals detected at elevated levels, chromium, copper, lead, mercury, and zinc are likely to be contaminants of concern because of their potential to biomagnify. Brief summaries of AWQC toxicity information (U.S. EPA 1986b) on each of these latter metals is presented in the following text. Similar toxicity profiles will be evaluated against site-specific concentrations data in the selection of contaminants of concern and key receptor species. The occurrence of these metals at elevated levels does not necessarily imply that they are available for assimilation in all organisms or that they transfer to successive trophic levels. The potential for adverse effects to occur is dependent of a number of physiochemical factors including: (1) physiological and ecological characteristics of the organism; (2) forms of dissolved trace metals; (3) forms of trace metals in ingested solids; and (4) chemical and physical characteristics of water (Jenne and Luoma 1977). Each of these factors will be considered in the evaluation of potential adverse environmental effects at OU5.

TABLE 9-2

COMPARISON OF OU5 METALS CONCENTRATIONS TO FEDERAL SURFACE WATER STANDARDS

	ALUMINUM	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CHROMIUM	COBALT
	SDWA MCL (Sec.) 50 to 200 µg/ℓ[a]	SDWA MCL 50 µg/ℓ	SDWA MCL 1000 µg/ℓ	CWA AWQC 130 µg/ℓ 5.3 µg/ℓ	CWA AWQC (Acute) 3.9 µg/ℓ (Chronic) 1.1 µg/ℓ	SDWA MCL 100 µg/ℓ[a]	
OU5							
POND C-1	1,420 µg/ℓ	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
POND C-2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
SW-32	24,800 µg/ℓ	N.D.	387 µg/ℓ	N.D.	N.D.	222 µg/ℓ	N.D.
SW-36	99,600 µg/ℓ	9.4 µg/ℓ	1,470 µg/ℓ	7.8 µg/ℓ	N.D.	118 µg/ℓ	61.8 µg/ℓ
SW-39	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

	COPPER	LEAD	MANGANESE	MERCURY	NICKEL	SELENIUM	ZINC
	CWA AWQC (Acute) 18 µg/ℓ (Chronic) 12 µg/ℓ SDWA MCL (Sec.) 1000 µg/ℓ	CWA AWQC (Acute) 82 µg/ℓ (Chronic) 3.2 µg/ℓ SDWA MCL 50 µg/ℓ	SDWA MCL (secondary) 50 µg/ℓ	CWA AWQC (Acute) 2.4 µg/ℓ (Chronic) .012 µg/ℓ SDWA MCL 2 µg/ℓ	CWA AWQC (Acute) 1,400 µg/ℓ (Chronic) 160 µg/l	CWA AWQC (Acute) 260 µg/ℓ (Chronic) 36 µg/ℓ SDWA MCL 10 µg/ℓ SDWA MCL 50 µg/L[a]	CWA AWQC (Acute) 120 µg/ℓ (Chronic) 110 µg/ℓ SDWA MCL 5000 µg/ℓ
OU5							
POND C-1	N.D	N.D.	599 µg/ℓ	1.8 µg/ℓ	N.D.	N.D.	228 µg/ℓ
POND C-2	N.D	N.D.	2,520 µg/ℓ	0.3 µg/ℓ	N.D.	N.D.	358 µg/ℓ
SW-32	25.2 µg/ℓ	24.8 µg/ℓ	622 µg/ℓ	0.3 µg/ℓ	N.D.	N.D.	201 µg/ℓ
SW-36	122 µg/ℓ	84.0 µg/ℓ	2,140 µg/ℓ	1.1 µg/ℓ	105 µg/ℓ	N.D.	413 µg/ℓ
SW-39	N.D.	N.D.	58.5 µg/ℓ	3 µg/ℓ	N.D.	N.D.	22.2 µg/ℓ

SDWA = Safe Drinking Water Act
MCL = Maximum Contaminant Level
AWQC = Ambient Water Quality Criteria
N.D. = Not Detected
(a) EPA National Primary and Secondary Drinking Water Regulations, 40CFR Parts 141, 142, and 143, Final Rule effective July 30, 1992.

Chromium(VI)

The toxicity of chromium is largely due to its oxidizing action in its hexavalent state (as chromic oxide, chromate, or dichromate) and its easy permeation of biologic membranes (NRC 1974). Acute toxicity values for chromium(VI) are available for freshwater animal species in 27 genera; these values range from 23.07 $\mu g/\ell$ for a cladoceran to 1,870,000 $\mu g/\ell$ for a stonefly. These species include a wide variety of animals that perform a wide spectrum of ecological functions. Daphnids are especially sensitive. The few data that are available indicate that the acute toxicity of chromium(VI) decreases as hardness and pH increase.

The chronic value for both rainbow trout and brook trout is 264.6 $\mu g/\ell$; while the chronic value for fathead minnow is 1,987 $\mu g/\ell$. Chronic tests using chinook salmon show a reduction in growth at low concentrations of 16 $\mu g/\ell$. Chronic values in soft water for daphnids range from <2.5 to 40 $\mu g/\ell$ and acute-chronic ratios range from 1.130 to >9.680. Green algae are quite sensitive to chromium(VI). The bioconcentration factor (BCF) for rainbow trout is less than 3.

Copper

The toxicity of copper to aquatic organisms is due primarily to the cupric (Cu^{2+}) ion and possibly to some of the hydroxy complexes. Concentrations of copper ranging from 1 to 8,000 $\mu g/\ell$ inhibit growth of various aquatic plant species. Sensitivities for aquatic invertebrates and fish are similar to those for plants. Acute toxicity data are available for species in 41 genera of freshwater animals. At a hardness of 50 mg/ℓ, the genera range in sensitivity from 16.74 $\mu g/\ell$ for Ptychocheilus to 10,240 $\mu g/\ell$ for Acroneuria. Acute toxicity generally decreases as water hardness increases. Additional data for several species indicate that toxicity also decreases with increases in alkalinity and total organic carbon.Chronic values are available for 15 freshwater fish species and range from 3.873 $\mu g/\ell$ for brook trout to 60.36 $\mu g/\ell$ for northern pike. Fish and invertebrate species seem to be equally sensitive to the chronic toxicity of copper.

Protection of animal species appears to offer adequate protection of plants. Copper does not appear to bioconcentrate very much in the edible portion of freshwater aquatic species. Many animals have some ability to cope with excess copper through excretion (Rand and Petrocelli 1985). In animals where copper is not excreted, copper will accumulate in tissues, especially liver.

Lead

The acute toxicity of lead to several species of freshwater animals has been shown to decrease as the hardness of water increases. At a hardness of 50 mg/ℓ, the acute sensitivities range from 142.5 $\mu g/\ell$ for an amphipod to 235,900 $\mu g/\ell$ for a midge. Data on the chronic effects of lead on freshwater animals are available for two fish and two invertebrate species. The lowest and highest available chronic values (12.26 and 128.1 $\mu g/\ell$) are both for a cladoceran, but in soft and hard water respectively. Freshwater algae are affected by concentrations of lead above 500 $\mu g/\ell$, based on data for four species. BCFs are available for four invertebrate and two fish species and range from 42 to 1,700.

Several enzymes are sensitive to lead at very low concentrations. Lead strongly inhibits several ATPases, lipoamide dehydrogenase, and aminolevulinic acid dehydratase, which is involved in the synthesis of heme (Rand and Petrocelli 1985). In vertebrate animals, lead poisoning is characterized by neurological defects kidney dysfunction, and anemia.

Mercury

Mercury is toxic to all forms of biota in aquatic ecosystems, although many factors (e.g., alkalinity, pH, and temperature) influence toxicity. The toxic action of mercury in plants and animals appears to involve cell membranes and their permeability. In mammals, early subacute poisoning generally has a neurological manifestation (Rand and Petrocelli 1985). Data are available on the acute toxicity of mercury(II) to 28 genera of freshwater animals. Acute values for invertebrate species range from 2.2 $\mu g/\ell$ for Daphnia pulex to 2,000 $\mu g/\ell$ for three insects. Acute values for fish range from 30 $\mu g/\ell$ for the guppy to 1,000 $\mu g/\ell$ for Mozambique tilapia. Few data are available for various organomercury compounds and mercurous nitrate, which are 4 to 31 times more acutely toxic than mercury(II).

Available chronic data indicate that methylmercury is the most chronically toxic of the tested mercury compounds. Tests on methylmercury with Daphnia magna and brook trout show chronic values less than 0.07 $\mu g/\ell$. For mercury(II), the chronic value for Daphnia magna is about 1.1 $\mu g/\ell$ and the acute-chronic ratio is 4.5. In both a life-cycle test and an early life-stage test on mercuric chloride with the fathead minnow, the chronic value was less than 0.26 $\mu g/\ell$ and the acute-chronic ratio was over 600.

Freshwater plants show a wide range of sensitivities to mercury, but the most sensitive plants appear to be less sensitive than the most sensitive freshwater animals to both mercury(II) and methylmercury. A BCF of 4,994 is available for mercury(II); BCFs for methylmercury range from 4,000 to 85,000.

Zinc

The levels of dietary zinc at which toxic effects are evident depend markedly on the concentration ratio of zinc to copper (Rand and Petrocelli 1985). Zinc is also a metabolic antagonist of cadmium, so that high zinc intakes in animals afford some protection against cadmium exposure. Acute toxicity values are available for 43 species of freshwater animals. Data indicate that acute toxicity generally decreases as hardness increases. When adjusted to a hardness of 50 mg/ℓ, sensitivities range from 50.70 $\mu g/\ell$ for Ceriodaphnia reticulata to 88,960 $\mu g/\ell$ for a damselfly. Additional data indicate that toxicity increases as temperature increases. Chronic toxicity data are available for nine freshwater species. Chronic values for two invertebrates range from 46.73 $\mu g/\ell$ for Daphnia magna to >5,243 $\mu g/\ell$ for the caddisfly, Clistoronia magnificia. Chronic values for seven fish species range from 36.41 $\mu g/\ell$ for flagfish, Jordanella floridae, to 854.7 $\mu g/\ell$ for the brook trout, Salvelinus fontinalis. The sensitivity range of freshwater plants is greater than that for animals. Growth of the alga, Selenastrum capriocornutum, is inhibited by 30 $\mu g/\ell$; however, 4-day EC50s for several other species of green algae, exceed 200,000 $\mu g/\ell$. Zinc bioaccumulates in freshwater animal tissues at 51 to 1,130 times the water concentration.

9.1.2.2 Radionuclides

Basic ecological research on radionuclides in the environment has a 40-year history resulting in sophisticated models for identification and prediction of the movement and concentration of specific radionuclides. The same is true for effects resulting from exposure to both external and internal sources of radiation. Most of the scientific literature concerning radioecology has resulted from interaction between DOE operated facilities and nearby universities.

The following discussion is a brief summary of the radionuclide literature reviewed. In general, transuranics tend to bind in the soils and sediments and have limited availability to biota. Bioaccumulation or concentration factors routinely are low between trophic levels. Data from Little et al. (1980) from the Rocky Flats Plant site indicate that radionuclide inventories (and thus radiation doses) in vertebrate populations are well below levels know to elicit effects. Based on the following cursory literature review, it seems unlikely that at the low dose levels reported, sufficient sensitive methods exist to distinguish adverse biological response from background "noise" (chance fluctuations due to climate, weather, human disturbance, etc.) at the Rocky Flats Plant Site.

Terrestrial Ecosystems

Historically, the principal reason for determining BCFs for terrestrial biota was to calculate the internal radiation dose to higher trophic levels at an equilibrium body burden from radionuclides assimilated from foodstuffs. For the most part, BCFs for mammals have been collected from fallout studies under widely varied habitat conditions (arctic, desert, temperature zone, and laboratory) and, consequently, there are few consistent generalizations. Concentration factors for ^{137}Cs typically show an increase from plants to mammalian herbivores as well as increases at the higher trophic levels. Ninefold increases in ^{137}Cs through the plant → mule deer → cougar food-chain were demonstrated in the work done by Pendleton et al. (1965). Also an increase of approximately 2 to 5 fold at each link in the lichen → caribou → wolf food-chain has been reported by Hanson et al. (1967).

Less comprehensive data are available for the other radionuclides, but it is evident that not all radionuclides are concentrated in food-chains and that different food-chains may exhibit markedly different concentration patterns for the same nuclide. Strontium-90 accumulation for the plant → herbivore chain ranges from 0.02 to 8.4; while the BCF's for ^{3}H, ^{60}Co and ^{131}I are less than 1.0 with the exception of 2.4 for seed → water → quail for ^{60}Co movement (Auerbach 1973).

There have been few field studies on the comparative uptake of actinides (transuranics) by biota from contaminated soils. Uranium, Th, and Pu transfer in terrestrial food-chains has not been well studied because of the difficulty and expense of analyzing these elements at low levels in biota and the frequent high degree of variation in field data that complicates statistical comparisons between different actinides. Field studies that have been conducted on soil-plant-animal transfer suggest that bioaccumulation of these elements does not occur. Hakonson (1975) indicates that at the Trinity Site, residual plutonium levels in soils, plants, and animals were approximately 10 times lower in small rodents than in the corresponding grass samples. This same trend has been noted in other studies as well (Garten and Daklman 1978, Garten et al. 1981). Bly and Whicker (1978) found that the mean ratio of ^{239}Pu in arthropods to ^{239}Pu in 0 to 3 cm soil at Rocky Flats Plant was $1{:}9\times10^{-3}$.

Little, Whicker, and Winsor (1980) conducted a comprehensive study in the grassland ecosystem around Rocky Flats. The overall conclusions mirror the previously mentioned works in that plutonium was not accumulated up through the food-chain. Additionally, the body burdens of biota were significantly lower than required to elicit a biological or ecological effect.

Most studies of radiosensitivities of soil fungal populations have been performed in the laboratory. Studies on the effects of irradiation of natural populations in the field have been rare and have suffered from inadequate controls (Stotsky and Mortenson 1959, and Stanovick, Giddens, and McCreery 1961)

A study by Edwards (1969), revealed distinct differences in radiosensitivities of various microarthropod groups, but all were killed at levels much lower than those lethal to microflora. Orbatid mites, the most radiation-resistant microarthropods, were killed by 200 kilorads. Auerbach et al. (1957) found that with lower radiation doses, a lag effect exists in growth rates in certain microarthropods, such as Collembola. Cawse (1969) noted that bacteria are the most tolerant to radiation up to about 2.5 megarads. Fungi are resistant up to about 1 megarad (Johnson and Osborne 1964).

Fraley and Whicker (1973) found native shortgrass plains vegetation to be very resistant to chronic gamma radiation at exposure rates varying from 0.01 to 650 R/hr. One of the most resistant species was Lepidium densiflorum which became dominant at exposure rates of 12 to 28 R/hr and was able to germinate, develop, and complete seed set at exposure rates greater than 28 R/hr. The level of radiation exposure in their study is many orders of magnitude greater than any encountered in the environment around facilities such as Rocky Flats. The authors also reported that while community changes were apparent, the parameters used (coefficient of community and diversity) lacked the sensitivity to measure such change.

A long-term project was initiated in 1968 at Oak Ridge National Laboratory (Styron et al. 1975) to assess effects of mixed beta and gamma radiation from simulated fallout on a grassland ecosystem. Extensive statistical analyses of data on numbers of individuals collected for each of 76 arthropod and 2 molluscan taxa have identified no lasting significant changes in similarity or species diversity of experimental versus control communities as the result of the long-term irradiation at low doses rates. Natural fluctuations in community dynamics obscured any possible radiation effects.

Mammal species and populations exhibit a similar resistance to chronic low-level exposures and even acute exposures required in excess of 100 rads to elicit reproductive, hemopoietic, or survivorships responses (Kitchings 1978).

Aquatic Ecosystems

Aquatic food-chain dynamics are similar to those previously described for terrestrial ones. On the whole, the actinides have no known biological function and do not show an affinity for muscle in higher trophic level organisms (Poston and Klopfer 1988). In a study conducted at the Savannah River Plant by Whicker et al. (1990), aquatic macrophytes were found to have the highest concentration ratio, primarily, the authors suggest, due to adsorption of sediment particulates to surfaces. All other trophic levels were found to have very low concentration ratios. In nearly all cases, concentrations of transuranics in vertebrate tissues were very low. One would expect very low concentrations of transuranics in vertebrate tissues because of the low concentrations in water, sediments, macrophytes, and invertebrates, and because of the generally low food-chain transfer factors of most transuranics (Bair and Thompson 1974, Eyman and Trabalka 1980).

Only 5 to 10 percent of the plutonium and americium in sediments in a process waste pond on the Hanford Reservation were found to be available for foodweb transfer (Emery et al. 1975). The remaining fraction appeared to be tightly bound to particles and would be transported ecologically in particulate form. Watercress had a Pu concentration about equal to the sediments while dragonfly larvae and snails had Am levels approximating the sediments. All remaining biota had Pu and Am concentrations which were generally well below those of the sediments. Goldfish in the pond concentrated small amounts of both isotopes.

With respect to the distribution of several long-lived radionuclides within aquatic ecosystems, the work of Whicker et al. (1990) tends to confirm and strengthen the concept that many radionuclides tend to reside entirely in the sediments. It appears that this is true for ^{137}Cs and the transuranium elements. The rule also seems to hold for different types of systems with widely varying limnological properties. As a consequence, only a very small fraction of the total system inventory can reside in the biotic components. For radionuclides that tend to sorb strongly to sediments, this distribution can probably be extended to most freshwater ecosystems.

9.1.2.3 Organic Compounds

Each of the organic compounds found at OU5 (Table 9-1) are on the RCRA Appendix VIII and IX Lists, the Superfund Target Compound List, and the EPA Clean Water Act Priority Pollutants Compounds List and each is known to cause adverse acute and chronic effects on aquatic life depending on their concentrations. Only two of the organic compounds listed in Table 9-1, phenol and di-n-butyl phthalate, are reported in Table 2-5 and Table 2-6 as being detected in surface water at OU5. Values for both of these compounds are less than the potential chemical-specific ARARs reported in Tables 3-1, 3-2, and 3-3 of this document. While these contaminants do not appear to be of concern based on these limited data, forthcoming data will be evaluated with respect to this determination. Chemicals which are readily accumulated by aquatic biota and are persistent in aqueous media (e.g., petroleum distillates) will require evaluation of their potential adverse affects on site-specific biota. While there is no history of their disposal, detection of pesticides, PCBs, or dioxins in the Phase I analytical program for abiotic media would also warrant further consideration in this environmental evaluation. Locations of elevated levels of such organic chemicals in groundwater will warrant evaluation due to the potential interaction with surface water and subsequent potential for exposure to receptor organisms.

9.1.3 Protected Wildlife, Vegetation and Habitats

9.1.3.1 Wildlife

The U.S. Fish & Wildlife Service has identified several listed endangered or threatened wildlife species which could possibly occur in the Rocky Flats Plant area. However, none is expected to occur because of lack of habitat. These species include the endangered bald eagle (Haliaeetus leucocephalus), the two threatened subspecies of peregrine falcon (Falco peregrinus tundris and F. p. anatum), the endangered whooping crane (Grus americana) and the endangered black-footed ferret (Mustela nigripes).

The bald eagle is primarily a winter resident around rivers and lakes, and the closest known nesting pairs are found at Barr Lake, 25 miles to the east of Rocky Flats. Although the Rocky Flats Plant Site lacks suitable bald eagle nesting habitat, bald eagles have been observed over the plant site, and one pair has been observed feeding regularly at Great Western Reservoir, located approximately 0.4 miles east of the site.

The whooping crane passes through Colorado during its spring and fall migrations. Whooping cranes, blown off their migration course, could use the Rocky Flats area as a night roost. These birds prefer large marshes and wetlands in broad open river bottoms and prairies. Such habitat is not present at Rocky Flats.

The two subspecies of peregrine falcon may occasionally occur in the Rocky Flats area as they hunt for prey. Nesting preferences are high cliff sides and river gorges, both of which are absent at Rocky Flats. However, nesting sites have been recorded to the west about 4 to 5 miles from the site.

The historical geographic range of the black-footed ferret coincides with that of prairie dogs, a principal prey species. Although black-footed ferret populations are now extinct in the wild, large prairie dog towns sufficient to support a black-footed ferret population (>80 acres for black-tailed prairie dogs) if found at Rocky Flats would be surveyed by approved methods (U.S. Fish and Wildlife 1986).

Several additional species are of special interest to the State of Colorado because they are endangered in the state, are game species, have small and/or declining populations, or are pest/nuisance species (Colorado Division of Wildlife 1981, 1982a, 1982b and 1985). These species will be identified and investigated during Task 2 and will be considered in the development of on-site food webs.

9.1.3.2 Vegetation

Ten federally-listed or proposed plant species occur in Colorado, all of which are western slope species. None of these is known or expected to occur on or near Rocky Flats. A number of candidate species for federal listing are known to occur in Jefferson and Boulder Counties but have not been identified at Rocky Flats.

9.1.3.3 Wetlands

Numerous regulations and acts have been promulgated to protect water-related resources, including wetlands. Wetlands play an important role in ecosystem processing and in providing habitat to a variety of plant and animal species. An assessment of Rocky Flats wetlands was completed in 1989 (EG&G 1990g); these wetlands currently fall under the jurisdiction of the U.S. Army Corps of Engineers. Wetlands occur along Woman Creek, portions of the South Interceptor Ditch, and Ponds C-1 and C-2. DOE activities with a potential to impact wetlands will follow regulations designed for their protection.

9.2 ENVIRONMENTAL EVALUATION TASKS

An environmental evaluation at OU5 is necessary for Rocky Flats Plant to meet the requirements of Sections 121(b)(1) and (d) of CERCLA. An environmental evaluation, in conjunction with the human health risk assessment, is required to ensure that remedial actions are protective of human health and the environment. Guidelines for conducting this evaluation, which is also called an ecological assessment, are provided by EPA in Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (U.S. EPA 1989c). Additional guidance is derived from EPA's Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document (U.S. EPA 1989d) and other guidance documents (Table 9-3).

The environmental evaluation is both a qualitative and quantitative appraisal of the actual or potential injury to biota other than humans and domesticated species due to contamination at OU5. The environmental evaluation is intended to reduce the inevitable uncertainty associated with understanding the environmental effects of contaminants present in OU5 and to give more definitive boundaries to that uncertainty during remediation.

The following plan for OU5 provides a framework for the review of existing data, the conduct of subsequent field investigations, and the preparation of the contamination assessment. Methodologies for the ecological and ecotoxicological field investigations (Tasks 3 and 9) are described in the Field Sampling Plan presented in Subsection 9.3.

9.2.1 Task 1: Preliminary Planning

This task includes a definition of the study area, a determination of the scope of the environmental evaluation, identification of DQOs, and a plan for obtaining consensus on selection criteria for contaminants of concern, key receptor species, reference areas, and the field sampling approach/design.

The scope of the environmental evaluation will describe the kind and amount of information that will be collected in the study. The biological parameters that are to be measured, estimated, and calculated will be described. The time period and boundaries of the evaluation will be designated. Depending on the available pathways for exposure and the habitats potentially exposed to contamination, the study area for this ecological assessment may extend beyond the boundaries of each IHSS and Woman Creek.

9.2.1.1 Selection Criteria for Contaminants of Concern

Because not all contaminants found at OU5 will have adverse effects on biota, the list of chemicals to be evaluated can be narrowed. Chemical and species-specific criteria (e.g., likelihood of exposure) will be used for selecting those contaminants that are of particular concern from an ecological perspective at OU5. Chemical, physical and toxicological criteria will be used in selecting contaminants of concern. Examples of the potential criteria to be evaluated in selecting contaminants of concern are shown in Table 9-4.

TABLE 9-3

EXAMPLES OF EPA AND DOE GUIDANCE DOCUMENTS AND REFERENCES FOR CONDUCTING ENVIRONMENTAL EVALUATIONS

Barnthouse, L.W., G.W. Suter, S.M. Bartell, J.J. Beauchamp, R.H. Gardener, E. Linder, R.V. O'Neill and A.E. Rosen. 1986. User's Manual for Ecological Risk Assessment. Environmental Sciences Division. Publication No. 2679, ORNL-6251.

U.S. DOE. 1988a. Comprehensive Environmental Response, Compensation, and Liability Act Requirements. DOE Order 5400.YY. Draft, September 1988.

U.S. DOE. 1988b. Radiation Effluent Monitoring and Environmental Surveillance. DOE Order 5400.XY, Draft, September 1988.

U.S. DOE. 1990c. Radiation Protection of the Public and the Environment. DOE Order 5400.5

U.S. EPA. 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. Office of Emergency and Remedial Response, Washington D.C., EPA/540/g-89/004.

U.S. EPA. 1988c. Superfund Exposure Assessment Manual. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-88/001.

U.S. EPA. 1988d. Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/2-88/003.

U.S. EPA. 1989c. Risk Assessment Guidance for Superfund Volume II Environmental Evaluation Manual. Interim Final. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/001.

U.S. EPA. 1989d. Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document. Office of Research and Development. EPA/600/3-89/013.

U.S. EPA. 1989e. Exposure Factors Handbook. Office of Health and Environmental Assessment. Washington, D.C. EPA/600/8-89/043.

U.S. EPA. 1990. Guidance for Data Useability in Risk Assessment. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/G-90/008.9.2.1 Task 1: Preliminary Planning

TABLE 9-4

POTENTIAL SELECTION CRITERIA FOR CONTAMINANTS OF CONCERN

Concentrations detected on site
Frequency of detection
Historical disposal information
- Type
- Quantity

Mobility in environmental media
Chemical fate (transport)
- Adsorption coefficient
- Partition coefficient (water-octanol)
- Water solubility
- Vapor pressure

Persistence
- Biodegradation
- Chemical degradation

Bioaccumulation potential
Bioavailability
Biotransformation potential
Background concentrations
Biochemistry
- Essential nutrient
- Enzyme inhibitor

Toxicity
Treatability

Although the selection process for contaminants of concern parallels that for the Human Health Risk Assessment, the lists may differ somewhat based on contaminant fate and transport characteristics and species-specific toxicities. Selection of the contaminants of concern will be evaluated in accordance with EPA guidance (U.S. EPA 1989c). The screening values for each the criteria will be used as tools to help select chemicals that need further assessment. They will not be used as limits which indicate absolute "no adverse effects" levels. Actual site-specific conditions will determine the potential for adverse effects in receptor species at OU5.

9.2.1.2 Identification of Key Receptor Species

Key receptor species are those species which are or may be sensitive to the particular contaminants of concern. Species at each trophic level within a food web, differ in their sensitivity and the ways they take in, accumulate, metabolize, distribute, and expel contaminants. The susceptibility of a particular organism also varies with the mechanism through which contaminants are taken up from the environment. In general, the following criteria determine the susceptibility of the species to a particular contaminant (U.S. EPA 1989c):

- The rapidity with which the contaminant is absorbed from the environment
- Sensitivity of the species's tissues to the dosage incurred
- Relationship between tissue sensitivity and the expression of symptoms of toxic injury
- The rapidity of repair or accommodation to the toxic injury

Selection of receptor species will depend on the ability to detect toxic injury in the organism or subsequent adverse effects to the population. National standards on the definitions of injury to biological receptors are found in the Natural Resource Damage Assessment Rule [40 CFR Subtitle A Section 11.62 (f)]. These include death, disease, behavioral abnormalities, cancer, physiological malfunctions, and physical deformation. Additional methods for detecting injury to biological resources are provided in the Type B Technical Information Document: Injury to Fish and Wildlife Species (U.S. Department of the Interior 1987). The procedures described in these documents provide a framework for determining what categories of effects might be observed in the field during the site visit and subsequent surveys and for selecting appropriate study methods to establish relationships between contaminant distribution and concentration in the physical environment and biological consequences in the receptor species and populations (Reagan and Fordham 1991). By using this approach to focus efforts on examining specific effects in key receptor species, costs and sampling efforts will be reduced.

The selection of key receptor species is in part a subjective decision based on species dominance or judged importance in the food chain. Selection criteria for key receptor species will include consideration of the following:

- Species' sensitivity
- Listing as rare, threatened, or endangered by a governmental organization
- Game species
- A key component of ecosystem structure and function (e.g., abundant prey for other important species

Additional criteria used in the selection of key receptor species include species' habitat preferences, food preferences and other behavioral characteristics which can determine population size and distribution in an area or significantly affect the potential for exposure. Key receptor species may include game species such as mule deer (Odocoileus hemionus) which is mobile and has a large home range; or an organism that is sedentary or has a more restricted movement such as plants, some invertebrates, and some small vertebrates. For contaminants that bioaccumulate, the effects are usually most severe for organisms at the top of the food chain (e.g., top predators). Examination of contaminant effects on these more mobile species may necessitate the integration of data from different OUs.

A checklist of OU5 biota will be developed in conjunction with the ecological field inventory. The initial list of key receptor species will be chosen from the checklist based on the selection criteria and will include organisms from each trophic level. The documented selection analysis will include an evaluation of the species' relation to potential contaminant exposure through both direct contaminant accumulation from the abiotic environment and bioaccumulation through the food chain. Examples of key receptors species likely to be on this list are presented in Table 9-5. This list will be refined as information is evaluated on known contaminant effects on these species (or similar species) and the documented levels of contamination present at the site.

Key receptor species will be selected from this list for subsequent detailed food web analyses and possible tissue sampling. Selection of key receptor species for tissue analyses will depend on the species' suitability for sampling, sample size requirements, results of the preliminary exposure assessment and expectation for finding contaminants in the tissues sampled (see Subsections 9.2.9 and 9.2.10).

TABLE 9-5

POTENTIAL KEY BIOLOGICAL RECEPTORS FOR ASSESSMENT OF ECOLOGICAL IMPACTS AT OU5

Community	Receptor Species
Periphyton	Green algae Blue-green algae
Benthic Macroinvertebrates	Mayflies (larvae) Caddis flies (larvae) Chironomids (larvae) Crayfish
Fish	Fathead minnow Bluegill
Reptiles	Garter snake Bull snake
Mammals	Deer mouse Northern pocket gopher Microtines Rabbit Coyote
Birds	Mourning dove Mallard Killdeer Red-winged blackbird Ring-necked pheasant Cormorant Blue heron Great-Horned owl
Terrestrial Invertebrates	Earthworms Grasshoppers
Grasses	Western wheatgrass Blue grama Cheatgrass
Shrubs/Forbs	Snowberry Willows Bindweed Sunflower Cattails Pondweed
Microbial Populations	Entire population

Final selection of the contaminants of concern and key receptor species will provide the basis for the contamination assessment (Tasks 4 through 7). In the contamination assessment, food webs and contaminant exposure pathways will be developed for OU5. Information on these food webs will be used to relate quantitative data on contaminants in the abiotic environment to adverse effects in biota and to evaluate potential impacts to biota due to contaminant exposure.

9.2.1.3. Reference Areas

Determination of criteria for selection and sampling of reference areas will be coordinated between operable units. Reference areas will be identified as needed for terrestrial, wetland, and aquatic species and will be selected based on measurement endpoints. Reference areas are likely to be selected to the west or north of RFP, away from potential effects associated with releases from either RFP or OU5.

Reference areas may be selected when current and historical data are not available to assess impacts from OU5 contaminants. One or more reference areas may be selected based upon their similarity to OU5, their lack of exposure to contamination from Rocky Flats or other sources and the selected measurement endpoint. If more than one habitat or ecosystem type (e.g., terrestrial and aquatic) is to be assessed at OU5, comparable reference areas may be established for each, or a reference area may be selected containing those habitats or ecosystem types in a comparable distribution. For OU5, at least one reference area may be located upstream of the assessment area unless conditions indicate the area is unsuitable as a reference area. Data collected at the reference area will be compared where possible to values reported in the scientific literature to demonstrate that the data represent a normal range of conditions. Methods used to collect data at the reference area will be comparable to those used at OU5.

The selection of reference areas would be made to meet DQOs (U.S. EPA 1989c) and the selected assessment and measurement endpoints. Two basic criteria would be employed in the selection and establishment of reference areas:

1. The reference areas will be similar to OU5 in terms of soil series, topography, aspect, vegetation, habitat types and plant and animal assemblages.

2. The reference areas, including vegetation and wildlife, have not been impacted by releases from OU5 or other RFP Operable Units.

9.2.1.4 Data Quality Objectives

The DQO development process will follow the three steps recommended by EPA (1989d). Step I of the DQO process involves preparing definitions and concise DQOs. Examples of Step I program DQOs for this environmental evaluation include the following:

- Identify appropriate site-specific receptor species, contaminants of concern, and exposure pathways to determine if there is a potential for adverse effects to occur as a result of contamination. This step includes determination of relevant contaminant concentrations in biological tissues.

- Evaluate the potential for impacts to occur to biological resources outside the boundaries of OU5 or Rocky Flats Plant.

- Evaluate the need for remediation to protect the environment.

Steps II and III of the DQO process include identification of data uses and needs and design of the data collection program. Products of Step II include proposed statements of the type and quality of environmental data required to support the DQOs, along with other technical constraints on the data collection program. The objective of Step III is to develop data collection plans that will meet the criteria and constraints established in Steps I and II. Step III results in the specification of methods by which data of acceptable quality and quantity will be obtained. The DQO development process will continue as scoping of the environmental evaluation becomes more refined. Additional Step I decision-type DQOs may be needed or data collection-type DQOs may be modified based on Task 1 and Task 2 results and subsequent refinement of the field sampling plan.

9.2.1.5 Field Sampling Approach/Design

In addition to the work plan, proper conduct of this environmental evaluation will depend upon design of the Field Sampling Plan. The Field Sampling Plan presented in Subsection 9.3 is designed to be flexible so that it can be revised as additional data are collected. Flexibility in the Field Sampling Plan will ensure that field data collection activities will be comparable to and compatible with previous data collection activities performed at the site while providing a mechanism for planning and approving new field activities. The Field Sampling Plan, in conjunction with Standard Operating Procedures (SOPs) for Ecology (Volume V) (in preparation by EG&G) and the Implementation Plan (in preparation by EG&G), will provide guidance for all field work by defining the sampling and data-gathering methods to be used on the project.

9.2.2 Task 2: Data Collection/Evaluation and Preliminary Risk Assessment

As an integral part of the RFI/RI process, Task 2 of the environmental evaluation will focus on accumulating and analyzing pertinent information on three major areas:

- Species, populations and food web interrelationships
- Types, distribution and concentrations of contaminants in the abiotic environment (e.g., soil, surface water, groundwater and air)
- Preliminary determination of potential exposure pathways and potential contaminant effects on OU5 biota based on literature review

The principal subtasks in Task 2 include Literature Review and Site Characterization. These subtasks will be performed in conjunction with the Task 3, Ecological Field Investigation. Information that will be developed from these tasks includes the following:

- Chemical inventory/Contaminants of Concern - Existing information including that obtained on chemical contaminants from other investigations at Rocky Flats and other DOE facilities will be used in the development of a preliminary list of contaminants of concern.
- Initial toxicity test data - Preliminary data on the toxicity of potentially complex chemical mixtures in OU5 surface waters.
- Descriptive field surveys - Inventory of OU5 biota and locations of obvious zones of chemical contamination, ecological effects, and human disturbance.
- Species inventory - Plant and animal species known to occur within OU5 or to potentially contact contaminants at OU5 and their trophic relationships.
- Population characteristics - General information on the abundance of key species.
- Food habit studies - Available information from literature sources to supplement field observations and possible gut content analysis on key species.

9.2.2.1 <u>Literature Review</u>

As an essential part of Task 2, a review of available documents, aerial photographs, and data relevant to the site will be completed. This will allow compilation of a database from which to determine data gaps and to provide evidence for a defensible field sampling program. Prior studies by DOE and the RFP operating contractors will be reviewed and evaluated. Information to be reviewed will include the following:

- Project files maintained by Rockwell International and EG&G
- Project reports and documents on file at Front Range Community College Library and the Colorado Department of Health
- DOE documents and DOE orders
- The Phase I database
- The Rocky Flats EIS database
- Data from ongoing environmental monitoring and National Pollution Discharge Elimination System programs
- Studies conducted at Rocky Flats on radionuclide uptake, retention and effects on plant and animal populations
- Scientific literature, including ecological and risk assessment reports, from other DOE facilities (Oak Ridge National Laboratory, Los Alamos, Hanford, Savannah River, Fernald)

If available and applicable, historical data will be used. Where the same methods are not used in the collection of new data, use of historical data will depend on the demonstrated comparability of the data collection methods.

9.2.2.2 <u>Site Characterization</u>

Environmental resources at the site will be characterized based on reviews of existing literature and reports, including results from the Phase I RFI/RI investigation, other operable unit RFI/RI investigations and the Task 3 ecological field investigation. The description of the site will be presented in terms of the following distinct resource areas:

- Meteorology/Air Quality
- Soils
- Geology
- Surface and Groundwater Hydrology
- Terrestrial Ecology
- Aquatic Ecology
- Protected/Important Species and Habitats

The purpose of the site characterization is to describe resource conditions as they exist without remediation. The narrative with supporting data will include descriptions of each resource, with attendant tables and figures, as appropriate, to depict, in a concise and clear fashion, site conditions, particularly as they influence contaminant fate and transport.

Included in this task is the development of a community food web model (Reagan and Fordham 1991) to describe the feeding relationships of organisms at Rocky Flats Plant. Food web construction begins with gathering information to evaluate the food habits of species or species groups (e.g., grasshoppers) found or potentially occurring on site. Standard computer searches will be augmented with searches of local university libraries to locate any regionally pertinent studies on food habits. The preliminary list of important species, compiled from background information, will be completed based on observations of presence and abundance made during the ecological site surveys and on trophic level data obtained from the food web model. Based on the model, a modified list of species will be made using toxicological information (toxicity assessment) to determine which species or species groups might be most affected or most sensitive to the chemical(s) of interest.

Data from past studies and preliminary data from current environmental studies will be used to better define the present distribution of contaminants in the abiotic environment and to develop an initial food web model. The food web model in conjunction with a preliminary pathways analysis will identify likely or presumed exposure pathways or combinations of pathways and receptor species at risk. Based on this preliminary information, the Task 3 and Task 9 field investigation sampling approach/designs may be revised.

9.2.3 Task 3: Ecological Field Investigation

The Phase I field investigation for OU5 consists of the following separate programs: the air program which will entail emissions estimation and modeling; the soils, surface water, and groundwater programs, which will be conducted as part of the Phase I RFI/RI activities; and the terrestrial and aquatic biota sampling program, which will be conducted as part of this environmental evaluation.

9.2.3.1 Air Quality

A site-wide air quality monitoring program is being conducted at Rocky Flats. These data can be used to model airborne transport of contaminants to potential receptors. Where the inhalation pathway is considered to be significant in the case of OU5 biota, a detailed pathways analysis and assessment of potential adverse effects using these transport model data will be performed.

9.2.3.2 Soils

Few data exist on contaminants present in surficial materials at OU5. Groundwater monitoring wells have been installed at several locations within the drainages, but all wells are outside OU5 IHSS boundaries. Soil samples from various depths in these wells were analyzed. These data have not been validated, and there is some uncertainty in the unvalidated data.

The purpose of the Phase I RFI/RI sampling and analysis program is to provide data for characterizing the IHSSs and for confirming the presence or absence of contamination. The Phase I RFI/RI Work Plan proposes to collect soil samples from each of the IHSSs at OU5. Surficial soil samples will be collected in the Ash Pits, the Original Landfill, and the Surface Disturbances areas. Surface soils samples will be analyzed for radionuclides and metals in the Ash Pits and proximal to the Original Landfill, and additionally for organics in the Surface Disturbance Areas. Soil samples will be collected from IHSS 115, Original Landfill, only where there are radiation hotspots or high soil gas readings. The list of soil analysis parameters is presented in Table 7-5, and the planned analytical program is presented in Table 7-6. In addition to these analyses, soil analyses will be conducted in the field and laboratory to confirm and clarify Soil Conservation Service descriptions and classifications. This information will be used to evaluate suitability of the soils for plant growth and to assist in the selection of suitable reference areas.

Surficial soil samples will be of prime importance for determining source contaminants for biota. This uppermost layer is a major source of nutrients and contaminant uptake for the vegetation under study and is also a potential source of contaminant ingestion to wildlife. Soil samples from all depths are related to surface water and groundwater regimes. Fluids moving through the soils can leach contaminants, transport them through available flow paths, and deposit them in downgradient environments. Contamination in soil and groundwater at a depth of greater than 20 feet (maximum depth of burrowing animals and plant root penetration) will not be considered to affect biota.

The sampling and analysis programs under the Phase I RFI/RI field investigations will be reviewed and modified as necessary to ensure that sampling intervals and methods are appropriate to collect surficial soil samples in the required locations. Data from the Phase III OU1 RFI/RI program and the Phase II OU2 RFI/RI Program will also be evaluated for use in characterizing the nature and areal extent of surface soil contamination in the vicinity of OU5. The information will be used to help identify exposure pathways for the environmental assessment.

9.2.3.3 Surface Water and Sediments

Surface water and sediment samples are collected on a regular basis as part of ongoing site-wide investigations. These investigations will continue. This Phase I RFI/RI Work Plan proposes extensive sampling along Woman Creek, the South Interceptor Ditch, and in Ponds C-1 and C-2. In addition, samples will be collected upstream of the Rocky Flats Plant to provide background data. Samples will be analyzed for metals, radionuclides, inorganics, and organics. Total organic carbon will also be determined in the sediment analyses.

Surface water sampling and analytical results presented in the Final Phase III OU1 RFI/RI Work Plan and the Draft Final OU2 RFI/RI Work Plan will be evaluated with respect to this environmental evaluation plan. Sampling locations presented in this work plan were integrated with OU1 and OU2 sampling locations. All seeps and springs on the Woman Creek Drainage will be sampled as part of these programs. Chemical results from the OU1 and OU2 surface sampling locations will be reviewed and incorporated into the OU5 environmental evaluation.

9.2.3.4 Groundwater

Groundwater monitoring wells upgradient and downgradient of some of the IHSSs provide limited information on groundwater conditions in Woman Creek Drainage. This Phase I RFI/RI proposes to install monitoring wells downgradient of the Original Landfill, Ash Pits, and Ponds C-1 and C-2. The laboratory analytical results will be used to assess the presence or absence of groundwater contamination and to assess the exposure pathway, if present.

Data from the Phase III OU1 RFI/RI Program and the Phase II OU2 RFI/RI Program will also aid in characterizing the nature and areal extent of groundwater contamination in the vicinity of the site. The hydrogeologic information and laboratory analytical results from these planned boring and well installation programs will likewise be incorporated in this environmental evaluation where applicable. The information will be used to assist in determining the nature and extent of contamination in shallow groundwater and help identify exposure pathways for the environmental assessment.

9.2.3.5 Terrestrial and Aquatic Biota

Terrestrial and aquatic species in the Rocky Flats Plant area have been described by several researchers (Weber et al. 1974; Clark 1977; Clark et al. 1980; Quick 1964; Winsor 1975; CDOW 1981; CDOW 1982a, 1982b); most of these reports are summarized in the Final EIS (U.S. DOE 1980). In addition, terrestrial and aquatic radioecology studies conducted by CSU and DOE (Rockwell International 1986; Paine 1980; Johnson et al. 1974; Little 1976; Hiatt 1977) along with annual monitoring programs at Rocky Flats Plant have provided information on the plants and animals in the area and their relative distribution.

Limited field surveys will be conducted in Task 3 to characterize current biological site conditions in terms of species presence, habitat characteristics and/or community organization. The emphasis will be to describe the structure of the biological communities at OU5 in order to identify potential contaminant pathways, biotic receptors, and key species.

Initial aquatic toxicity tests using Ceriodaphnia spp. and fathead minnows will be conducted at OU5 under Task 3. Standardized EPA acute and chronic test methods will be followed in accordance with NPDES toxicity testing procedures currently being used at Rocky Flats.

Vegetation

The objectives of the vegetation sampling program are to provide data for: (1) the description of site vegetation characteristics; (2) identification of potential exposure pathways from contaminant releases to higher trophic-level receptors; (3) selection of key species for contaminant analysis to determine background conditions for OU5; and (4) identification of any protected vegetation species or habitats.

A number of habitat types are expected to be found in the Woman Creek Drainage (Clark et al. 1980). Grasses characteristic of the short grass plains are expected to be abundant. Representative species include blue grama (Bouteloua gracilis), Junegrass (Koeleria cristata), dropseed (Sporobolus spp.), slender wheatgrass (Agropyron trachycaulum), and green needlegrass (Stipa viridula), which are interspersed with other grasses, shrubs, and a variety of annual flowering plants. Transects will be established at each of the IHSSs, along the South Interceptor Ditch, and along Woman Creek Drainage to collect phytosociological data on density, cover, frequency, and species presence.

Wetland Vegetation

Wetlands have been identified along Woman Creek and the South Interceptor Ditch (EG&G 1990g). These occur as linear wetlands that support hydrophytic vegetation species including sandbar willow (Salix exigua), american watercress (Barbarea orthoceras), and plains cottonwood (Populus sargentii). Other species associated with these wetlands include broad-leaf cattail (Typha latifolia), baltic rush (Juncus articus), cordgrass (Spartina pectinata), silver sedge (Carex praegracilis), and various bulrushes (Scirpus spp.). Transects will be established in wetland vegetation habitats along the South Interceptor Ditch and Woman Creek and around Ponds C-1 and C-2 to collect phytosociological data on density, cover, frequency, and species presence.

Periphyton

The periphyton community is a closely-adhering group of organisms that form mat-like communities on rocks, other solid objects, or the stream bottom. The community is composed of algae, bacteria, fungi, detritus, and other macroscopic heterotrophic organisms. Because of the large surface-to-volume ratio of its constituents, periphyton have been found to be an excellent indicator community for accumulation of contaminants. Periphyton samples will be collected at designated locations on the South Interceptor Ditch, along Woman Creek, and at Ponds C-1 and C-2.

Periphyton communities provide a sensitive mechanism to detect changes in aquatic environments that result from the introduction of contaminants. Taxonomic composition and relative abundance of periphyton can be measured on natural substrates as well as standardized artificial substrates. On hard artificial substrates, data on algal abundance, biomass, and species composition will be obtained by removing the substrate and by scraping or brushing the flora from a measured area into a container.

Benthic Macroinvertebrates

Benthic macroinvertebrates may exist in rocky/gravelly substrates or as soft bottom communities along portions of Woman Creek, the South Interceptor Ditch, and Ponds C-1 and C-2. The soft-bottom benthos are those macroscopic invertebrates inhabiting mud or silt substrates, whereas the immature stages of insects inhabit rock surfaces, rooted stems, and leaves or gravelly substrates. Because these communities are essentially stationary, they are good indicators of past and present habitat contamination. Additionally, their feeding methods (filtering microscopic organisms and fine materials, preying on smaller invertebrates, and grazing periphyton), suggest that benthic species are ingesting other organisms that are potentially concentrating contaminants. Designated locations in the South Interceptor Ditch, Woman Creek, and Ponds C-1 and C-2 will be sampled for benthic organisms.

Fish

Fish can be important components of ecological assessments because they are relatively long-lived, occupy upper trophic levels of aquatic ecosystems, and they may spend their entire lives in relatively small areas. Fish species representing both herbivores and carnivores are likely present in OU5 aquatic habitats and may demonstrate biomagnification of contaminants within the pond or creek ecosystem.

Terrestrial Wildlife

A field survey will be conducted to gather data on animal communities at Woman Creek Drainage. The objective of the animal life survey is to: (1) describe the existing animal community at Woman Creek Drainage; (2) identify potential contaminant pathways through trophic levels; (3) develop food web models including contribution from vegetation; (4) identify key species for potential collection and tissue analysis; and (5) identify any protected species.

The field survey will document the presence of terrestrial species and allow for a general description of the community. Some species (e.g., songbirds, larger mammals, reptiles, and raptors) may use the area daily, seasonally or sporadically, or wander through as vagrants. Survey timing and techniques will consider these uses.

9.2.4 Contamination Assessment (Tasks 4 through 7)

The contamination assessment includes Tasks 4 through 7. The two major objectives of the contamination assessment are to:

- Obtain quantitative information on the types, concentrations, and distribution of contaminants in selected species

- Evaluate the effects of contamination in the abiotic environment on ecological systems

Conducting a contamination assessment requires an evaluation of chemical and radiological exposures and the subsequent toxicological effects on key species. Of specific importance in the contamination assessment are the identification of exposure points, the measurement of contaminant concentrations at those points, and the determination of potential impacts or injury. Impacts may result from movement of contaminants through ecological systems or from direct exposure (inhalation, ingestion, or deposition).

The Contamination Assessment for OU5 will be based on existing environmental criteria, published toxicological literature, and existing, site-specific environmental evaluations. The program design will be integrated with other ongoing RFI/RI studies so that concentrations of contaminants in abiotic media can be related to contaminant levels and effects in biota. A preliminary contamination assessment will be made in Task 2 based on the site characterization and contaminant identification activities. The preliminary Task 2 assessment will be used to revise the Task 9 ecotoxicological field investigation sampling design. The contamination assessment process described in the following tasks will include the development of a site-specific pathways model to quantify the potential for contaminant exposure and adverse effects in biota.

The objectives and description of work for each of the contamination assessment tasks is described below.

9.2.5 Task 4: Toxicity Assessment

This assessment will include a summary of the types of adverse effects on biota associated with exposure to site-related chemicals, relationships between magnitude of exposures and adverse effects, and related uncertainties for contaminant toxicity, particularly with respect to wildlife. Ecological receptor health effects will be characterized using EPA-derived critical toxicity values when available in addition to selected literature pertaining to site- and receptor-specific parameters.

The toxicity assessment will provide brief toxicological profiles centered on health effects information on wildlife populations. The profiles will cover the major health effects information available for each contaminant of concern. Data pertaining to wildlife species will be emphasized, and information on domestic or laboratory animals will be used when wildlife data are unavailable.

9.2.6 Task 5: Exposure Assessment and Pathways Model

This task will identify the exposure or migration pathways of the contaminants, taking into account environmental fate and transport through both physical and biological means. Each pathway will be described in terms of the chemical(s) and media involved and the potential ecological receptors. The exposure assessment process will include the following three subtasks:

- Identify exposure pathways
- Determine exposure points and concentrations
- Estimate chemical intake for receptors

Each of these subtasks is described below.

9.2.6.1 <u>Exposure Pathways</u>

The purpose of this subtask is to qualitatively identify the actual or potential pathways by which various biological receptors at or near OU5 might be exposed to site-related chemicals or radionuclides. The exposure pathway analysis will address the following four elements:

- A chemical/ radionuclide source and mechanism of release to the environment

- An environmental transport medium (e.g., soil, water, air) for the released chemical/ radionuclide

- A point of potential biological contact with the contaminated medium

- A biological uptake mechanism at the point of exposure

All four elements must be present for an exposure pathway to be complete and for exposure to occur. Exposure pathways will be evaluated and modeled, where possible. Toxicity tests, such as those proposed for Task 3, can be used to conduct a direct effects-related investigation. Additional toxicity tests may be designed based on the pathways model results.

9.2.6.2 Determination of Exposure Points and Concentrations

The identified exposure points are those locations where key ecological receptor species may contact the contaminants of concern. Potential for exposure depends on characteristics of the contaminant, the organism, and the environment. Determination of exposure points entails an analysis of key receptor species, locations, and food habits in relation to potential contaminant exposure both through direct contaminant accumulation or deposition from the abiotic environment and through indirect bioaccumulation. The exposure assessment for OU5 will provide information on the following:

- What organisms are actually or potentially exposed to contaminants from OU5
- What the significant routes of exposure are
- What amounts of each contaminant organisms are actually or potentially exposed to
- Duration of exposure
- Frequency of exposure
- Seasonal and climatic variations in conditions which are likely to affect exposure
- Site-specific geophysical, physical, and chemical conditions affecting exposure

A determination of the nature and extent of contamination in the abiotic media (air, soils, surface water, and groundwater) is presented in this Phase I RFI/RI Work Plan for Woman Creek Drainage. Phase I data, where available, will be summarized and used to characterize source areas and release characteristics at the site. The exact exposure points can be expected to vary depending on both the contaminant and the key receptor species under consideration.

Concentrations of chemicals that are likely to have the greatest impact (based on concentration in the environment, toxicity values, and biological uptake) will be determined by environmental fate and transport modeling or actual environmental media sampling for each exposure point. Fate, transport, and endpoint contamination levels will be modeled using environmental multi-media risk assessment models. Such models can provide the potential maximum concentrations of chemicals at the exposure points by which to evaluate the "worst-case" scenario.

9.2.6.3 Estimation of Chemical Intake by Key Receptor Species

This step includes an evaluation of key receptor species' contaminant uptake by direct routes (i.e., inhalation, ingestion, dermal contact) and indirect routes (bioconcentration, bioaccumulation, biomagnification). The amounts of chemical and radiological uptake will be estimated using appropriate conservative assumptions, site-specific analytical data, and forthcoming guidance from EPA's Wildlife Exposure Factors Handbook (to be published in 1991). A pathways analysis model (Reagan and Fordham 1991; Thomann 1981) will be used to establish relationships between concentrations of a chemical in different media with concentrations known to cause adverse effects.

Direct measurement of contaminant uptake through tissue analyses will be conducted during Task 9 of the environmental evaluation. Such site-specific data and field observations will be used to reduce uncertainty in the pathways model and strengthen interpretation of the overall study.

9.2.7 Task 6: Contamination Characterization

Contamination characterization entails the integration of exposure concentrations and reasonable worst-case assumptions with the information developed during the exposure and toxicity assessments to characterize current and potential adverse biological effects (e.g., death, diminished reproductive success, reduced population levels, etc.) posed by OU5 contamination. The potential impacts from all exposure routes (inhalation, ingestion, and dermal contact) and all media (air, soil, groundwater, and surface water/ sediment) will be included in this evaluation as appropriate according to EPA guidance (U.S. EPA 1989c).

Characterization of adverse effects on receptor species and their populations is generally more qualitative in nature than characterizing human risks. This is because the toxicological effects of most chemicals have not been well documented for most species. Criteria that are usable and applicable for the evaluation of ecological effects are generally limited. EPA AWQC and Maximum Allowable Tissue Concentrations (MATC) are the most readily available criteria. Criteria found in federal and Colorado state laws and regulations pertaining to the preservation and protection of natural resources can also be used. Criteria may also be derived from information developed for use under other environmental statutes, such as the Toxic Substances Control Act or the Federal Insecticide, Fungicide and Rodenticide Act. An attempt will be made to consider the adverse effects of chemicals on populations and habitats rather than on individual members of a species according to EPA guidance (1989c, 1989d). Where specific information is available in the published literature, a more quantitative evaluation of effects will be made using the site-specific pathways model. This approach is in agreement with EPA guidance (U.S. EPA 1989c).

9.2.8 Task 7: Uncertainty Analysis

The process of assessing ecological effects is one of estimation under conditions of uncertainty. To address uncertainties, the OU5 environmental evaluation will present each conclusion, along with the issues that support and fail to support the conclusion, and the uncertainty accompanying the conclusion. Factors that limit or prevent development of definitive conclusions will also be discussed. In summarizing the assessment data, the following sources of uncertainty and limitations will be specified:

- Variance estimates for all statistics
- Assumptions and the range of conditions underlying use of statistics and models
- Narrative explanations of other sources of potential error

Validation and calibration of the pathways model will also be used where practicable.

9.2.9 Task 8: Planning

Task 8 will include planning for tissue analysis studies and any additional ecotoxicological studies needed to assess adverse effects from the contaminants of concern on receptor species. Initial designing for the Task 9 ecotoxicological field investigations will begin after contaminants of concern and key receptor species have been selected in Task 2. Species to be sampled for tissue analyses will be designated to the earliest extent possible in order to avoid a duplication of the Task 3 sampling effort.

The need for measuring additional ecotoxicological endpoints in Task 9 will be evaluated based on the pathways analyses and published information on direct toxic effects. Selection of field methodologies will be based on a review of available scientific literature providing quantitative data for the species of concern or similar test species. Analysis of population, habitat, or ecosystem changes will be based on species or habitats that represent broad components of the ecosystem or are especially sensitive to the contaminants. In order to select methodologies for the ecotoxicological field sampling program, the biological response under consideration and the proposed methodology should satisfy program DQOs as well as the following more specific criteria:

- The biological response is a well-defined, easily identifiable, and documented response to the designated contaminant(s) of concern (i.e., methodology and measurement endpoint are appropriate to the exposure pathway)

- Exposure to the contaminant is known to cause the biological response in laboratory experiments or experiments with free-ranging organisms

- Methodology is capable of demonstrating a measurable biological response distinguishable from other environmental factors such as weather or physical site disturbance

- The biological response can be measured using a published standardized laboratory or field testing methodology

- The biological response measurement is practical to perform and produces scientifically valid results (e.g., sample size is large enough to have useful power and small Type II error)

Tissue studies to document site-specific contamination will be conducted in Task 9 for both aquatic and terrestrial systems. Tissue analyses will be conducted on selected species from OU5 and reference areas to document current levels of specific target analytes. Information from the Task 2 data evaluation and Task 3 field survey will determine the species and contaminants to be tested and the methods to be used. Selection of the target analytes, species, and tissues will depend on an initial determination as to which contaminants are likely to adversely impact biota and which contaminants are likely to be present in concentrations sufficient for detection.

Acute and chronic aquatic toxicity tests using fathead minnows and Ceriodaphnia spp. are proposed for Task 3 (see Subsection 9.3.5). These simple screening tests will provide an initial determination of the toxicity of potentially complex chemical mixtures in Woman Creek, the South Interceptor Ditch, and Ponds C-1 and C-2. If toxicity is observed in either the acute or chronic tests at any one station, then a supplemental toxicity testing program in conjunction with physical and chemical analyses of the water and sediment may be designed for that location to determine the potential extent of the toxicant(s).

Toxicity testing methods are available for terrestrial ecosystems using microbes, earthworms, crickets, and grasshoppers (U.S. EPA 1989c). The need for such tests will be evaluated based on the above criteria as part of this planning process.

Prior to conducting Task 9 studies, the field sampling plan will be refined to address the proposed methodologies. More specific DQOs will be formulated based on the proposed methodologies and will address the following:

- The number and types of analyses to be run
- The species, locations, and tissues to be sampled
- The number of samples to be taken
- The detection limits for contaminants
- The acceptable margin of error in analyzing results

9.2.10 Task 9: Ecotoxicological Field Investigations

Tissue analyses will comprise most of the Task 9 ecotoxicological field investigation. Tissue analyses will be conducted to measure the total concentration of specific chemical compounds in key receptor species. Because individuals and species accumulate contaminants differentially in their tissues depending on the exposure route and form of the contaminants, environmental concentrations and general uptake rates will not necessarily predict biotic concentrations or adverse effects. Analysis of tissue contaminant concentrations will provide data to evaluate the predicted relationship, if any, between environmental concentrations and the amount of contaminants accumulated in receptor species. Selection of the species and specific tissues for analysis will be based on a preliminary evaluation of site-specific food webs, potential contaminant transport pathways and potential for bioaccumulation, bioconcentration, and biomagnification. Whole bodies or specific tissues will be analyzed depending on which portion is consumed by higher trophic level organisms. Suitability of the species for sampling and sampling size requirements will largely determine the species to be selected for tissue analysis.

To the extent possible, tissue samples will be collected simultaneously with environmental media samples. This will allow for a determination of site-specific BCFs. These BCFs will be incorporated into the final exposure assessment and will be used to calibrate/validate the pathways model. Where BCFs cannot be determined, published or predicted BCF values will be used in the pathways model to assess potential impacts.

Statistical tests will be used in the measurement of the contaminant-specific biological response in samples from OU5 and the reference areas. Use of statistical tests will be consistent with DQOs and quality assurance provisions of the Quality Assurance Project Plan (QAPjP).

Additional ecotoxicological studies or toxicity tests may include in-situ (in-field) and/or laboratory toxicity tests. In-situ methods usually involve exposing animals in the field to existing aquatic or soil conditions. Laboratory toxicity tests can be used to evaluate the lethal or sublethal effects of chemicals as they occur in environmental media. Both approaches can be used to test for toxicity of mixtures as they actually occur in the environment. Selection of a particular methodology is generally based on the capability of the method to demonstrate a measurable biological response to the selected contaminant(s) of concern in addition to those specific criteria presented in Subsection 9.2.9.

9.2.11 Task 10: Environmental Evaluation Report

Task 10 will include the summary of information and production of an Environmental Evaluation Report as part of the RFI/FI Report. The Environmental Evaluation Report will be prepared in a clear and concise manner to present study results and interpretation. All relevant data from the environmental evaluation, in addition to relevant Phase I RFI/RI data, will be integrated and evaluated in the characterization of potential environmental impacts. The following topics will be covered in the report:

- Objectives
- Scope of Investigation
- Site Description
- Contaminants of Concern and Key Receptor Species
- Contaminant Sources and Releases
- Exposure Characterization
- Impact Characterization
- Remediation Criteria
- Conclusions and Limitations

A proposed, detailed outline of the report is shown in following Table 9-6.

Remediation Criteria

Remediation criteria protective of site-specific plants and animals for the contaminants of concern can be developed in Task 10 based on ecological effects criteria and detailed food-web analyses using a calibrated/validated pathways model. Ecological effects criteria are determined by tracing the biomagnification of contaminant residues from organisms at the top of the food web back through intermediate trophic levels to the abiotic environment. The "no effects" criteria levels for abiotic media are then derived from contaminant concentrations known to produce sublethal effects in the most sensitive (usually highest trophic level) organisms. Development of ecological effects criteria for OU5 will be based on results of the pathways model as well as available data which document potential adverse effects from contaminants of concern on key biological receptors. The process for establishing ecological criteria is shown in Figure 9-2. Determination of these criteria for OU5 will be coordinated with other RFI/RI studies and environmental evaluations.

TABLE 9-6
PROPOSED ENVIRONMENTAL EVALUATION REPORT OUTLINE
WOMAN CREEK DRAINAGE

EXECUTIVE SUMMARY

1.0 INTRODUCTION

1.1 OBJECTIVES
1.2 SITE HISTORY
1.3 SCOPE OF EVALUATION

2.0 SITE DESCRIPTION

2.1 PHYSICAL ENVIRONMENT

2.1.1 Air Quality/Meteorology
2.1.2 Soils
2.1.3 Surface Water
2.1.4 Groundwater

2.2 BIOTIC COMMUNITY

2.2.1 Freshwater Community
2.2.2 Terrestrial Community
2.2.3 Protected/Important Species and Habitats

3.0 CONTAMINANT SOURCES AND RELEASES

3.1 SOURCES
3.2 RELEASES

4.0 CONTAMINANTS OF CONCERN

4.1 CRITERIA DEVELOPMENT FOR SELECTION OF CONTAMINANTS OF CONCERN
4.2 DEFINITION OF CONTAMINANTS

5.0 TOXICITY ASSESSMENT

5.1 TOXICITY ASSESSMENTS OF CONTAMINANTS OF CONCERN
5.2 CONTAMINANT EFFECTS

5.2.1 Terrestrial Ecosystems
5.2.2 Aquatic Ecosystems

6.0 EXPOSURE ASSESSMENT

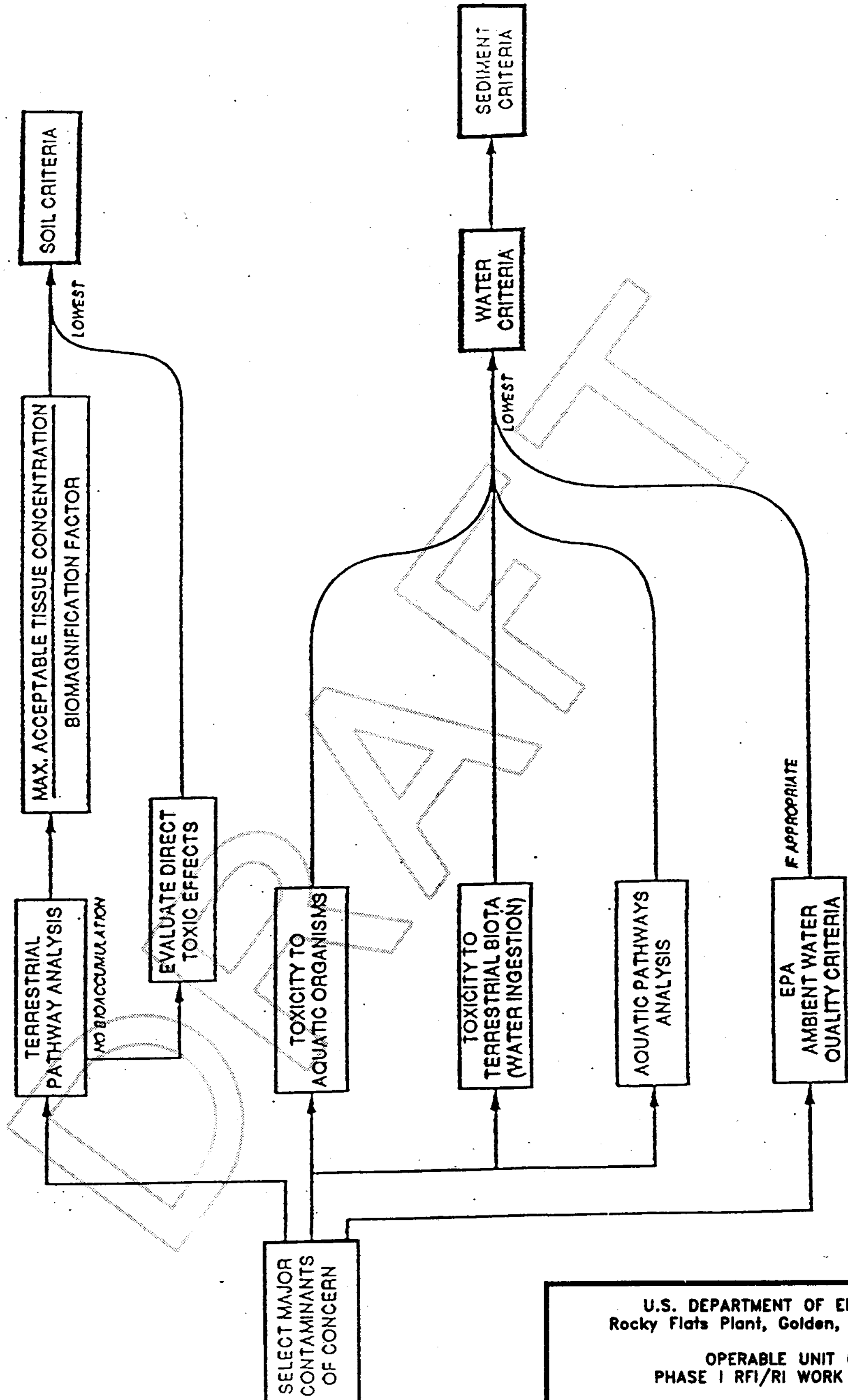
6.1 CONTAMINANT PATHWAYS AND ACCEPTABLE CRITERIA DEVELOPMENT

6.1.1 General Methodology for Pathway Analysis
6.1.2 Selection of Key Receptor Species

6.2 EXPOSURE POINT IDENTIFICATION

6.2.1 Soil
6.2.2 Water
6.2.3 Vegetation

TABLE 9-6
(Concluded)



SOURCE: REAGAN AND FORDHAM, 1991

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

OUTLINE OF THE METHODOLOGY FOR DETERMINING CRITERIA FOR MAJOR CONTAMINANTS OF CONCERN

FIGURE 9-2 MARCH 1991

The acceptable (no-effects) criteria levels will be used in conjunction with ARARs to evaluate potential adverse effects on biota as appropriate for the environmental evaluation portion of the Phase I RFI/RI. This approach will be integrated with the Human Health Risk Assessment process and will assist in the development of potential remediation criteria.

9.3 FIELD SAMPLING PLAN

The OU5 Environmental Evaluation is planned in 10 tasks as described in Subsection 9.2. Field sampling activities will be conducted in Task 3 and Task 9 of the environmental evaluation. Task 3 will include brief field surveys, an ecological inventory of biota present at OU5, and initial aquatic toxicity testing. The field surveys and inventory will be conducted to obtain information on the occurrence, distribution, and general abundance of biota in OU5. Data obtained in the field inventory will be used to identify key receptor species, to develop a site-specific food web model and to provide input to the pathways analysis and contamination assessment. Planning for the Task 9 tissue analysis program will begin in Task 2 so that samples collected in the Task 3 field inventory may be used wherever possible (i.e., where contaminants of concern have been defined and field sampling protocol have been developed). Final determination of the need for further ecotoxicological studies (e.g., reproductive success, population studies or enzyme analyses) in Task 9, will be made in Task 8, Planning, after completion of the contamination assessment.

The following field sampling plan is provisional and will be periodically revised as appropriate. The Task 3 sampling plan is largely complete but may be altered in order to better coordinate with the surface water and soil sampling programs for OU5 or other operable units. The Task 9 field sampling plan will be designed in greater detail after contaminants of concern and key receptor species have been identified and a preliminary determination of food webs and contaminant source-receptor pathways has been developed). This information will allow determination as to which contaminants of concern are likely to be present in sufficient concentrations to be detected in biota and which biota are most practical and suitable for sampling.

SOPs for sampling biota as part of the Environmental Evaluation process at Rocky Flats are currently in publication. The SOPs will include discussion of purpose and scope, responsibilities and qualifications, references, equipment, and execution of protocols. Sampling procedures for the following organisms will be included in the forthcoming document:

- Periphyton
- Benthic Macroinvertebrates
- Plankton
- Fishes
- Large Mammals

- Small Mammals
- Birds
- Reptiles and Amphibians
- Terrestrial Arthropods
- Terrestrial Vegetation
- Soil Microbes

SOPs that are currently being developed in addition to the above include the following:

- Design of Field Sampling Plans
- Selection of Reference Areas
- Recording and Managing Data
- Preserving and Handling Samples
- Conducting Laboratory Studies
- Incorporating QA/QC

The preceding SOPS are referenced in the following OU5 Field Sampling Plan where appropriate.

9.3.1 Sampling Objectives

The Task 3 Ecological Field Investigation for OU5 has four broad objectives:

1. Conduct brief field surveys and an ecological inventory to describe the existing ecological setting in terms of habitats, vegetation, wildlife and aquatic species. Conduct initial aquatic toxicity testing using Ceriodaphnia spp. and fathead minnows. Observe OU6 for obvious signs or zones of contamination or injury to biota and their habitats will be made. Accomplish ecological field inventory, through the use of established ecological field methodologies (e.g., Mueller-Dombois and Ellenberg 1974; Southwood 1978; Krebs 1989).

2. From the above data, identify key food web species which represent the major flow of energy and nutrients and thus the major pathways for contaminant transfer from physical environmental media to higher trophic-level ecological receptors.

3. Identify the presence or absence of protected or other important species and habitats.

4. Provide site-specific information for determining objectives, measurement endpoints and methodologies for Task 9 field/laboratory contamination studies.

Data from the field survey, inventory and aquatic toxicity tests will be summarized, tabulated and accompanied with a narrative description of the following data types:

- Species Present (Diversity)
- Habitat Descriptions/ Mapping Units (Clark et al. 1980)
- Soil Descriptions/ Classifications (part of RFI effort)
- Critical/ Protected Habitats
- Protected Species
- Terrestrial and Aquatic Food Webs
- Potential Exposure Pathways
- Abundance of Key Species
- Vegetation Cover
- Vegetation Frequency and Density (shrubs/trees)
- Vegetation Importance (community dominance) Values
- Aquatic Toxicity Test Results

Appropriate statistical tests will be used to analyze the data so that precision and accuracy of the results can be presented at a stated level of confidence. Depending on the data types being analyzed, within-and-between station differences, within-and-between season differences, and within-and-between species differences will be presented. Means, variances, standard errors, analyses of variance, regression, and correlation coefficients will be computed as appropriate. Where sample sizes are insufficient to detect differences, only descriptive statistics will be prepared.

9.3.2 Sample Location and Frequency

Both Task 3 and Task 9 field sampling activities for OU5 will be located and timed to the extent possible to coincide with collection of other media samples (soils, surface water, and groundwater) as well as sampling activities at other operable units. This integrated sampling approach is consistent with EPA guidance and will provide a synoptic view of potential contaminants in all relevant media at one time.

The field sampling plan for Task 3 is based on the assumption that brief field surveys will be conducted in the spring, summer, fall and winter and that the ecological field sampling program will take place within the May-June and July-August timeframes. Aquatic toxicity testing will take place in May-June (high flow) and September-October (low flow). Information from the initial surveys and field inventory may be used to modify sampling parameters for later field investigations.

9.3.2.1 Locations for Vegetative Sampling

Vegetation sampling for phytosociological data will be performed at OU5 IHSSs, at the Surface Disturbance south of the Ash Pits, along the South Interceptor Ditch, and along Woman Creek. A systematic walk-through of these areas will be conducted in the spring, summer, and fall to observe species composition.

A stratified randomization procedure will be utilized to identify sampling locations for the quantitative vegetative description portion of the field inventory. The basis for selecting a random procedure of vegetation transect/plot location is to obtain as unbiased an estimator as possible of true population parameters for herbaceous cover and shrub/tree density and frequency. Stratification is required because several distinct vegetation types appear to be present in the study area, including prairie grassland, marsh, streambank vegetation, well-vegetated disturbed areas, and sparsely vegetated disturbed areas.

The basis for stratification will be a vegetation type map, to be prepared based on the 1975 University of Colorado vegetation map of Rocky Flats and the Clark et al. (1980) report, updated by visual observations during the field surveys. This map will cover Woman Creek Drainage.

Transects for the quantitative community surveys will be located near soil sampling sites (see Subsection 7.2) wherever possible. From each soil sampling point, the centerpoint of a vegetation transect will be selected based on a random distance (to 10 m) and random direction, using random numbers tables. Transect locations will be selected until an adequate number has been selected for each major vegetation type at each IHSS. Locations will be discarded under several conditions: where the selected location is in a vegetation type for which an adequate number of transects has already been selected (for each IHSS); where the vegetation is not homogeneous (i.e., located in more than one type or across an ecotone); and where the transect would be located in buildings or paved areas. A similar process will be used for transects along Woman Creek and the South Interceptor Ditch, where the sample locations will be located in the general area of the surface-water/sediment sampling points. Since vegetation types associated with these features tend to be linear, the randomization process may require limits on direction. Multiple transects will be located near (within 50 meters of) each surface water/ sediment sampling point to provide an adequate sample size.

9.3.2.2 Locations for Periphyton, Macrobenthos and Fish Sampling

Periphyton, macrobenthos and fish samples will be collected at the following surface water sampling locations: SW-26, SW-32, SW-36, SW-39, SW-46, SW-70, SW-126, Pond C-1, and Pond C-2 (Figure 9-3). Should the organisms or proper habitat be absent at a particular location, then the nearest location downstream with suitable habitat will be sampled and located on a map. Sampling at OU5 will be coordinated with OU5 surface water and sediment sampling activities as well with OU1 and OU2 sampling programs. Both sediment and surface water quality data will be collected at the same locations and time as the aquatic biota sampling. Sampling locations may be altered to ensure these efforts are coordinated. Sampling locations for aquatic biota may also be altered depending on DQOs or required sample size.

9.3.2.3 Locations for Wildlife Sampling

A terrestrial wildlife inventory will be conducted within OU5 and along Woman Creek and the South Interceptor Ditch. Small mammal sampling will be conducted, to the extent possible, at the vegetative sampling locations. Searches for reptiles will be conducted in appropriate habitats in OU5.

9.3.2.4 Locations for Initial Toxicity Testing

Locations for initial aquatic toxicity testing will be mostly the same as those for periphyton, macrobenthos and fish sampling: SW-26, SW-32, SW-36, SW-39, SW-126, Pond C-1, and Pond C-2 (Figure 9-3). Toxicity testing activities for OU5 will be coordinated with toxicity testing activities proposed for OU2.

9.3.2.5 Tissue Sampling Locations

Locations for the collection of tissue samples (terrestrial vegetation, periphyton, benthos, macrobenthos, fish) will be the same as those for terrestrial and aquatic sampling. An initial identification of species for tissue sampling will be made in Task 2. Additional sampling requirements will be determined during the contamination assessment (Tasks 4 through 7) and contaminant data from surface water, soil and sediment sampling. The intent is to collect tissue samples where existing abiotic media sampling has indicated significant contamination to occur. Development of the OU5 tissue sampling program will be coordinated with OU1 and OU2 programs.

9.3.2.6 Sample Frequency

Brief field surveys will be conducted during 1-week periods in the spring, summer, fall, and winter. Special note of transitory species, migratory species, and seasonal breeding habits will be made during these multi-season surveys.

Field inventory sampling will occur during the May-June and July-August timeframes. Samples collected during the inventory will be saved and used in the tissue analysis studies where sampling and analysis protocol have been established.

Initial toxicity tests will also be conducted during May-June (high flow) and September-October (low flow). Two acute and two chronic tests will be conducted within 1 to 2 weeks of each other during each season. If toxicity is observed in either acute or chronic tests at any one station, then a supplemental program will be designed for that location to determine if the toxicity is consistent and to determine the potential extent of the toxicant.

9.3.3 Reference Areas

Tissue analysis studies may require the sampling of contaminated and control areas in order to establish a relationship between contaminated conditions and background conditions in areas not exposed to RFP contamination. Selection of reference areas may be based on criteria developed in the Task 1 preliminary planning process and may be coordinated with similar efforts at other operable units. Potential selection criteria include species to be sampled or similarity to OU5 in terms of topography, aspect, soils, vegetation, range type and land use history. Reference areas should be upwind from prevailing air flow patterns through RFP and upstream from drainage off RFP.

SOPs for sampling biota as part of the Environmental Evaluation process at Rocky Flats are currently in publication. Additional aquatic reference areas ideally should be located in Rock Creek. A site visit will be made of the proposed aquatic sampling locations for OU5, OU1, and OU2. Habitat characteristics will be noted if not previously recorded in ongoing RFP studies (depth, flow, substrate type, pool/riffle, aquatic/streamside vegetation, etc.). This process will be repeated at potential reference sites. The reference site locations will be based on Task 1 criteria, DQOs, and the selected assessment/measurement endpoints.

9.3.4 Field Survey and Inventory Sampling Methods

Sampling methods for periphyton, benthic macroinvertebrates, fishes, mammals, birds, reptiles and amphibians, terrestrial arthropods, and terrestrial vegetation are detailed in the Ecology SOPs. The SOPs include several standardized forms to be used when sampling biota. Site Description Form 5.0D will be used for sampling terrestrial biota; stream and pond habitat description forms (Forms 5.0A and 5.0B) will be completed at each of the aquatic sampling locations. Chain-of-custody field sample forms will be completed where samples are collected for laboratory analysis or voucher specimens. Additional forms to be completed are specified in the following subsections.

9.3.4.1 Vegetation

Both qualitative and quantitative methods will be used to characterize the terrestrial and wetland vegetation at OU5. Qualitative surveys using a relevé analysis (see Ecology SOPs) will be conducted in the spring, summer, and fall to record the floristic composition of the plant communities present.

These qualitative surveys will include a systematic walk-through of the IHSSs, Woman Creek, and the South Interceptor Ditch. The following data will be recorded on all vegetation species encountered:

- Scientific name
- Common name
- Life form
- Vegetative stage at the time
- Qualitative statement on condition
- Qualitative statement on abundance (relevé analysis - see Ecology SOPs)

Quantitative procedures will be used to collect structural and compositional data. Point-intercept transects will be used to collect data on species cover. Data will be recorded on Form 5.10B, point-intercept data form. Belt transects will be used in conjunction with the point-intercept transects to collect data on shrub cover and density. Trunk diameter, height, canopy diameter, and species will be recorded for any trees within the belt transect or within any IHSS. Shrub and tree data will be recorded on Form 5.10C, belt transect data form. Production data (standing biomass) will be collected from 1/4- to 1-m^2 quadrants at the same locations as the transects. Different quadrant sizes may be used depending on vegetation type (e.g., a 1/4-m^2 quadrant may be used on dense streambank vegetation). Production data will be recorded on Form 5.10D.

Each plot or 10-meter length of transect will be considered as an observation in calculating the mean and variance. Sample adequacy will be determined for total herbaceous cover/total fresh weight biomass using Cochran's formula (1977):

$$N = \frac{(t^2)(s^2)}{[(x)(d)]^2}$$

where: N = the minimum number of samples needed
t = t distribution value for a given level of confidence
s^2 = the variance estimate
x = the mean of the sample
d = the level of accuracy desired

9.3.4.2 Terrestrial Wildlife and Invertebrates

The Task 3 survey is planned to note the presence or absence of terrestrial/wetland species and to make note of their food habits. The survey procedure will include a systematic walk-through of OU5 area, including the South Interceptor Ditch and Woman Creek to record ecological features. Field data will be recorded on the standardized qualitative survey/relative abundance data form 5.0C for large mammals, small mammals, birds, reptiles and amphibians, and terrestrial arthropods. Opportunistic observations of bird and raptor nests, large mammal pellets and mammal burrow/dens will be recorded on the appropriate forms. Vocalization surveys for birds and anurans will also use the appropriate forms. Data to be recorded include:

- Species encountered/ observed
- Scientific name
- Common name
- Qualitative statement on:
    - Condition
    - Abundance
    - Habitat requirements
    - Predator/prey species/food habits
    - Regulatory status (to be determined prior to field sampling)
- Species presence will be determined by:
    - Visual observation
    - Vocalization
    - Burrow/den
    - Nest
    - Droppings/scat

Quantitative information on wildlife populations will be obtained in the Task 3 field inventory. Inventory sampling will include the following procedures which are detailed in the SOPs:

- Live trapping of small mammals on the adjacent hillsides and along the South Interceptor Ditch and Woman Creek. Data to be recorded include:
    - Scientific name/common name
    - Sex
    - Reproductive condition
    - Weight
    - Life history stage

- Reptile occurrence will be recorded along the same transects used for small mammal trapping in addition to habitat searches. Data to be recorded include:

  - Species encountered
  - Activity
  - Habitat
  - Qualitative statement on abundance

- Medium- and larger-sized mammals will be counted by recording all species along a systematic walk-through of OU5 including the South Interceptor Ditch and Woman Creek. The counting will occur during the small mammal transect trapping. Species encountered and activity will be recorded.

- Foliage invertebrates will be collected by sweep net and beating. Where conditions permit, foliage invertebrate and arthropod sampling may be conducted using a D-vac suction sampler in place of sweep netting (see Ecology SOPs). Data to be recorded will include:

  - Host plant
  - Herbivore
  - Position in food web

9.3.4.3 Periphyton

Sampling to characterize periphyton communities will occur at the selected locations along Woman Creek, the South Interceptor Ditch and Ponds C-1 and C-2 (see SOP). Data to be collected include:

- Scientific name
- Algal density (cell counts)
- Biomass (chlorophyll-a and phaeophytin-a concentrations)

Field data will be recorded on the periphyton field sample form 5.1A (see SOP). Data from quantitative sampling will be used to determine species diversity and standing crop (biomass). All analyses will be completed within five days of the collection of the slides from the field (U.S. EPA 1987).

9.3.4.4 Macrobenthos

Benthic invertebrates are the most common fauna used in ecological assessments of contaminant releases and are defined as the invertebrates retained by screens of mesh size greater than 0.2 mm.

Macrobenthos will be sampled at the aquatic sampling locations shown in Figure 9-3 using the procedures described in the SOPs. Triplicate samples will be taken on a transect upstream and within 10 meters of the designated sampling locations. Data to be collected include:

- Scientific name (generally to genus)
- Number of individuals in each taxon

Field data will be recorded on the benthic macroinvertebrate field sample Form 5.2A. Data from quantitative samples will be used to determine macroinvertebrate density (standing crop), taxa richness, species diversity and ratio of pollution-tolerant and pollution-sensitive taxa.

9.3.4.5 Fish

Fish will be collected in 10- to 25-meter-long collection areas using a backpack shocker or by seining blocked-off creek sections. In Ponds C-1 and C-2, fish will be sampled from a flat-bottom boat using an electroshocker. Data to be collected include:

- Scientific name
- Number of individuals in each taxon
- Length
- Weight

Scales will be collected to obtain data on age classes versus size, population structure and survivorship. Field data will be recorded on the fish field inventory form 5.4B (see SOP). Samples will be taken for laboratory identification/confirmation. Analyses will consist of compiling and summarizing the number, size, and weight of each species of fish captured at each sampling site. Graphic presentations may include fish length-frequency histograms and plots of catch per effort for each sampling area.

9.3.5 Initial Toxicity Tests

The initial toxicity testing program will be limited to aquatic organisms and will include standardized EPA acute and chronic tests with fathead minnows and Ceriodaphnia spp. Water samples will be cooled to 4°C and shipped to the laboratory conducting the toxicity tests within 12 to 24 hours. The toxicity tests will be initiated within 36 hours of the field collection time. The duration of the static renewal acute tests will be 48 hours for Ceriodaphnia and 96 hours for fathead minnows. The test water will be renewed daily using dilution water from the sampling station. The static renewal chronic tests will last for 7 days for fathead minnows and until 60 percent of the Ceriodaphnia in the control vessels have three broods. Quality control procedures will conform to the EPA requirements for NPDES toxicity testing currently being used at Rocky Flats and to the QAPjP.

9.3.6 Tissue Analysis Sampling Methods

The methodologies selected for tissue analysis studies will depend on the contaminants of concern and their anticipated effects on the selected key receptor species. Contaminants of concern and key receptor species will be determined as early as possible in Task 2. It is anticipated that some biota samples collected in the Task 3 field inventory can be used for tissue analysis. Standardized site protocol for preserving samples for tissue analyses will be followed in those instances where it is anticipated that tissue analyses will be conducted.

Analyses for metals and radionuclides in biota may call for a greater biomass of tissue than is available through standard collection methods. At least 80 grams of material (wet weight) is needed per sample for metals analysis, and 100 grams of material (dried and ashed) is needed for radionuclides. Obtaining this amount of sample may be impractical for some species of vegetation, periphyton, benthos, and macrobenthos. It is also not the intent of the sampling program to cause unnecessary disturbance or damage to the biota communities in order to collect sufficient samples. Sampling design will be adequate to ensure statistically valid results. DQOs for the tissue sampling program will be evaluated with respect to this determination prior to field collection activities.

Based on the literature reviewed and the information presented in this report, it is anticipated that most tissue samples will be analyzed for metals and very few samples, if any, may be analyzed for radionuclides. Tissue samples collected for contaminant analysis will be sent to a laboratory for specific metals and radionuclide analyses as determined in the preliminary Task 1/Task 2 environmental evaluation. Analytical methods will follow SOPs.

Holding times, preservation methods, sample containers, and field and laboratory quality control sample numbers are contained in the Quality Assurance Project Plan (QAPjP) and shown in Table 9-7. Tissue sampling protocol for biota are not necessarily standardized and may vary depending upon the laboratory conducting the analyses. Specific sample preparation requirements will be reported in SOPs which are currently in development.

9.3.7 Sampling Equipment

Equipment for field sampling of biota are identified in the Volume V Ecology SOPs.

9.4 SCHEDULE

The following Figure 9-4 presents a proposed schedule for implementation of the OU5 environmental evaluation. The schedule follows the task approach presented in this environmental evaluation. While many of the tasks are sequential, most tasks will overlap in time. The months indicated in the table reflect the timeframe in which the activity will occur and not necessarily the amount of time necessary to complete the task. The schedule is provisional and likely to change depending on the Phase I OU5 RFI/RI activity schedule as well as schedules from other operable units.

TABLE 9-7

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size++
SAMPLES FOR METALS ANALYSES				
TERRESTRIAL VEGETATION				
- Metals Determined by ICP**	6 mos	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Metals Determined by GFAA+	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	5 g
Periphyton, Benthic Macroinvertebrates, Fish				
- Metals Determined by ICP	6 mos.	Freeze & ship w/dry ice	Plastic	25 g
- Metals Determined by GFAA	6 mos	Freeze & ship w/dry ice	Plastic	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Plastic	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Plastic	5 g

TABLE 9-7
(Concluded)

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size++
SAMPLES FOR RADIONUCLIDE ANALYSES				
Terrestrial Vegetation				
- Uranium-233, 234, 235, 238 Americium-241 Plutonium-239/240	6 mos	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	100 g
Periphyton, Benthic Macroinvertebrates, Fish				
- Uranium-233, 234, 245, 238 Americium-241 Plutonium-239/240	6 mos	Freeze & ship w/dry ice	Plastic	100 g

**ICP = Inductively Coupled Argon Plasma Emission Spectroscopy. Metals to be determined include Ba, Cr, Cu, and Fe.

+GFAA = Graphite Furnace Atomic Absorption Spectroscopy. Metals to be determined include As, Cd, Li, Pg, Se, and Sr.

++ Sample size may vary with specific laboratory requirements.

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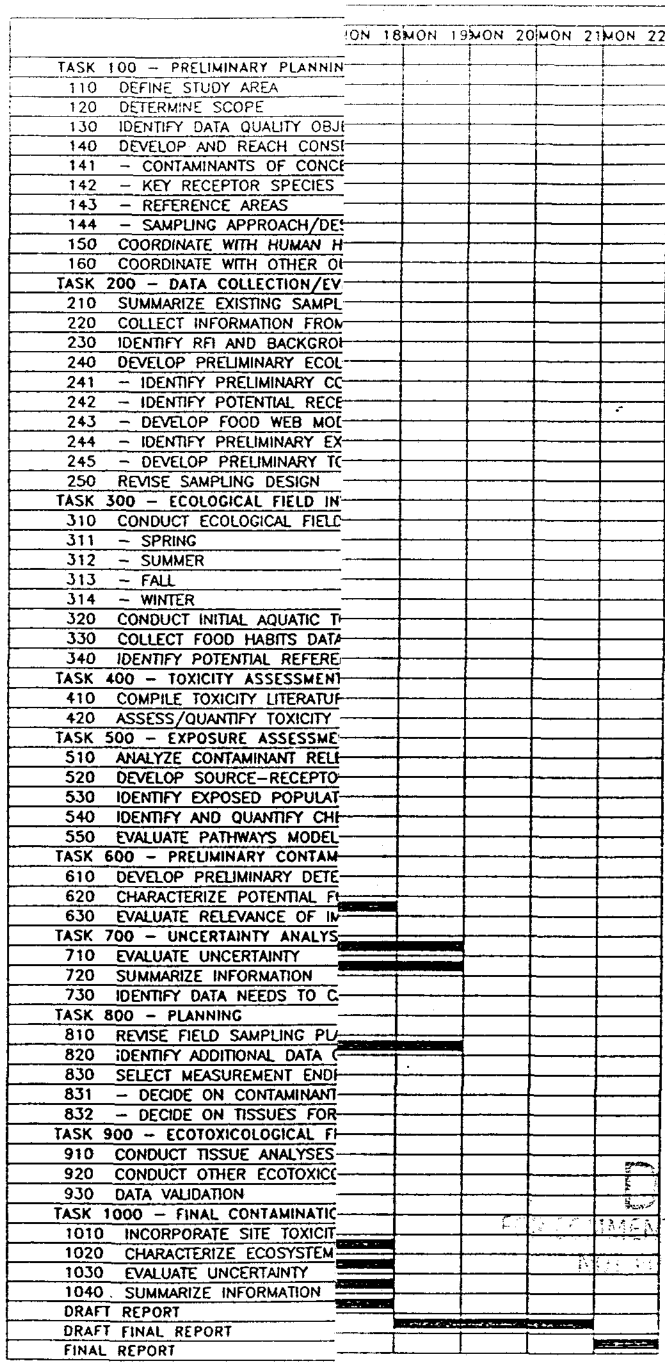

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

WOMAN CREEK DRAINAGE
ENVIRONMENTAL EVALUATION
ACTIVITY SCHEDULE

FIGURE 9–4 MARCH 1991

10.0
QUALITY ASSURANCE ADDENDUM

[The Quality Assurance Addendum [QAA] is currently being prepared by EG&G.]

The following Rocky Flats Plant (RFP) program-wide Standard Operating Procedures (SOPs) will be used during the specific field investigations for Operable Unit Number 5 (OU5):

- 1.13 Containerizing, Preserving, Handling and Shipping Soil and Water Samples
- 1.14 Data Base Management
- 1.16 Field Radiological Measurements
- 2.1 Water Level Measurements in Wells and Piezometers
- 2.2 Well Development
- 2.5 Measurement for Groundwater Field Parameters
- 2.6 Groundwater Sampling
- 3.1 Logging Alluvial and Bedrock Material
- 3.2 Drilling and Sampling Using Hollow-Stem Auger Techniques
- 3.6 Monitoring Well and Piezometer Installation
- 3.8 Surface Soil Sampling
- 3.9 Soil Gas Sampling and Field Analysis
- 4.1 Surface Water Data Collection Activities
- 4.2 Field Measurement of Surface Water Field Parameters
- 4.3 Surface Water Sampling
- 4.6 Sediment Sampling
- 4.8 Pond Sampling

In addition, Field Operations, Volume I, SOPs will also be used, as appropriate, during field operations.

Specific information concerning sampling activities is provided in the Field Sampling Plan (FSP) (Section 7.0) for most of the sampling activities. Project-specific details for this work plan will be included in the Standard Operating Procedures Addenda (SOPAs). These SOPAs will be attached to the SOP for use during field activities.

11.1 ADDENDUM TO SOP NO. 4.6, SEDIMENT SAMPLING

Sediment samples will be collected from five locations, each, in Ponds C-1 and C-2 and from numerous locations within Woman Creek and the South Interceptor Ditch (SID). The sediment samples from the ponds will be collected from the following locations:

- The deepest part of the pond
- Within the pond, 5 feet from the pond inlet
- Three locations selected at random within the area of the pond at the time of sampling

Sediment samples in Woman Creek will be collected within the channels in locations conducive to the collection of sediments.

The sediment samples at each location will be collected such that they represent the entire vertical column of sediment at the sampling location. Currently, the depth of sediment in the Detention Ponds is unknown. Samples will be collected at 2-foot intervals. All of the sediment samples, except the one from the deepest part of each pond, will be vertical composite samples that represent the entire sediment thickness, up to 2 feet. If the sediment depth is greater than 2 feet, 2-foot composite samples will be collected. The samples from the deepest part of each pond will be composited at 5-centimeter intervals, instead of 2-foot intervals.

Samples from Woman Creek will be collected according to SOP No. 4.6, Sediment Sampling. These samples will be collected with a core sampling device capable of obtaining a sample of the entire thickness of sediment at a given location, which can be logged. Samples for analysis of volatile or semivolatile organic compounds will be collected as grab samples and not composited.

Sediment samples from the Detention Ponds will be collected with a King tube sampler with a diameter of not more than 2 inches. Several soil cores may be needed to obtain enough samples for analyses. One of the samples will be maintained in the vertical position and frozen for subsequent geologic logging. This frozen core will be logged according to SOP No. 3.1, with the thickness and character of any thin stratifications in the sediment column noted. The sediment samples collected for chemical analysis will then be composited at 5-centimeter intervals. Sample handling and decontamination procedures will be followed as described in SOP No. 4.6, Sediment Sampling.

11.2 ADDENDUM TO SOP NO. 4.8, POND SAMPLING

Water samples will be collected from five locations, each, in Ponds C-1 and C-2. The specific locations are as follows:

- The deepest part of the pond
- Within 5 feet of the pond inlet
- Within 5 feet of the pond spillway
- Two locations selected at random within the pond

Prior to sampling at each sampling point, profiles of water temperature and dissolved oxygen in the water column will be collected at the sampling location. The Hydrolab® Multi-Parameter Measuring Instrument will be used to collect the profiles across the entire water column.

All of the samples except the one from the deepest part of the pond will be vertical composite samples representing the entire depth of the water column at the sampling point. The sampling from the deepest part of the pond will consist of taking grab samples from each of the zones of stratification identified in the water column at that point.

11.2.1 Composited Samples

Following the measurement of temperature and dissolved oxygen at the sampling point, a sample will be collected. The sample may be collected using a regulated flow sampler (described in SOP No. 4.3, Surface Water Sampling), which is pulled through the entire column of water. Samples may also be collected using a peristaltic pump with the intake tubing pulled through the entire water column. VOC samples will be collected as described in SOP No. 4.8, Pond Sampling.

Field parameters such as pH and specific conductance will be measured in the composited sample in accordance with SOP No. 2.5.

11.2.2 Grab Samples

Temperature and dissolved oxygen at the sampling point in the deepest part of the pond will be measured to determine the location of stratified layers at this point. The grab samples will then be collected using a peristaltic pump in each stratified zone for all samples except VOC samples. The uppermost stratified zone will be sampled first, followed by the next lower zone, and so on. The zone at the bottom of the pond will be sampled last. VOC samples will be collected as described in SOP No. 4.8, Pond Sampling.

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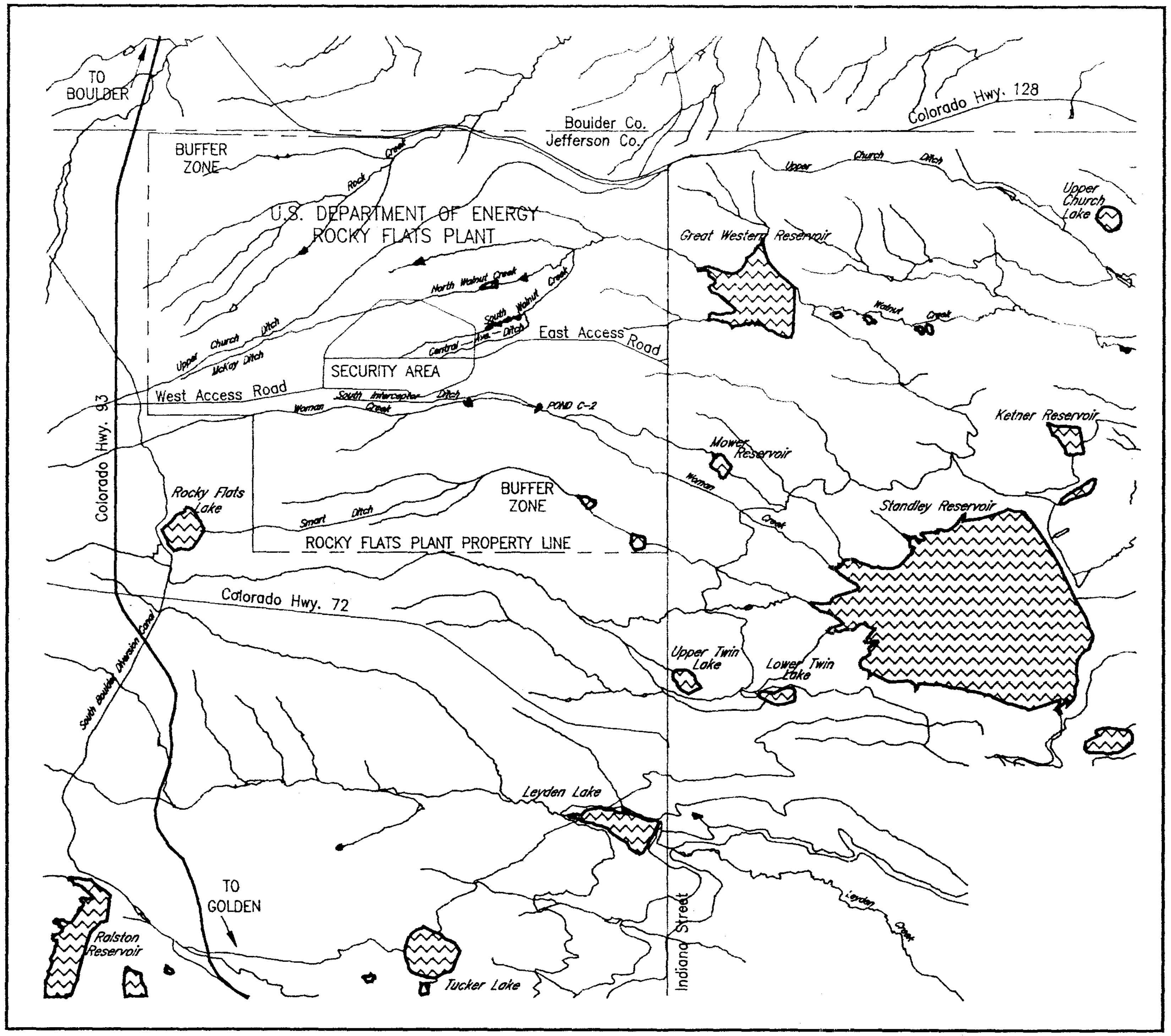
APPENDIX A
AS BUILT DRAWINGS FOR POND C-2



SOURCE: EG&G 1991d

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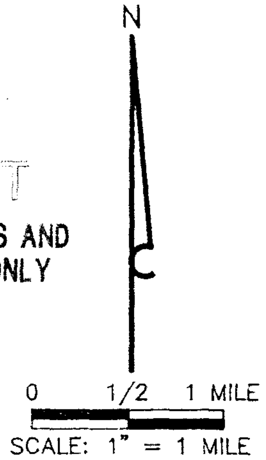


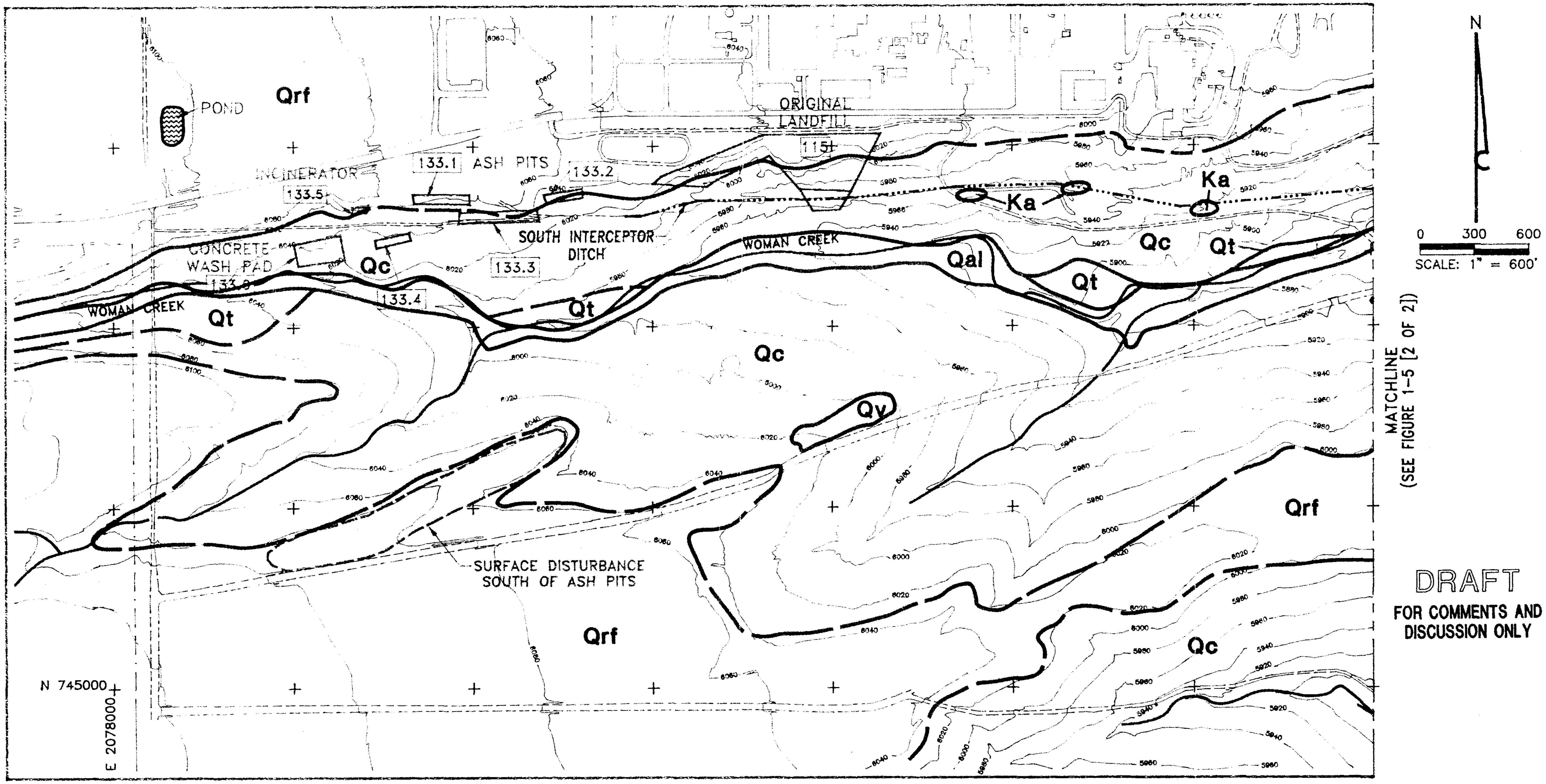
EXPLANATION

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT
BOUNDARIES AND BUFFER ZONE

FIGURE 1-2 MARCH 1991



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EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5

115 IHSS REFERENCE NUMBER

SOUTH INTERCEPTOR DITCH

DIRT ROAD

PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE

CONTACT

?—? DASHED WHERE APPROXIMATELY LOCATED, QUERIED WHERE INFERRED.

QUATERNARY

Qal	RECENT VALLEY FILL
Ql	LANDSLIDE
Qc	COLLUVIUM
Qt	TERRACE ALLUVIUM
Qs	SLOCUM ALLUVIUM
Qv	VERDOS ALLUVIUM
Qrf	ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass	ARAPAHOE FORMATION, SANDSTONE
Ka	ARAPAHOE FORMATION, CLAYSTONE

SOURCE: EG&G 1990c

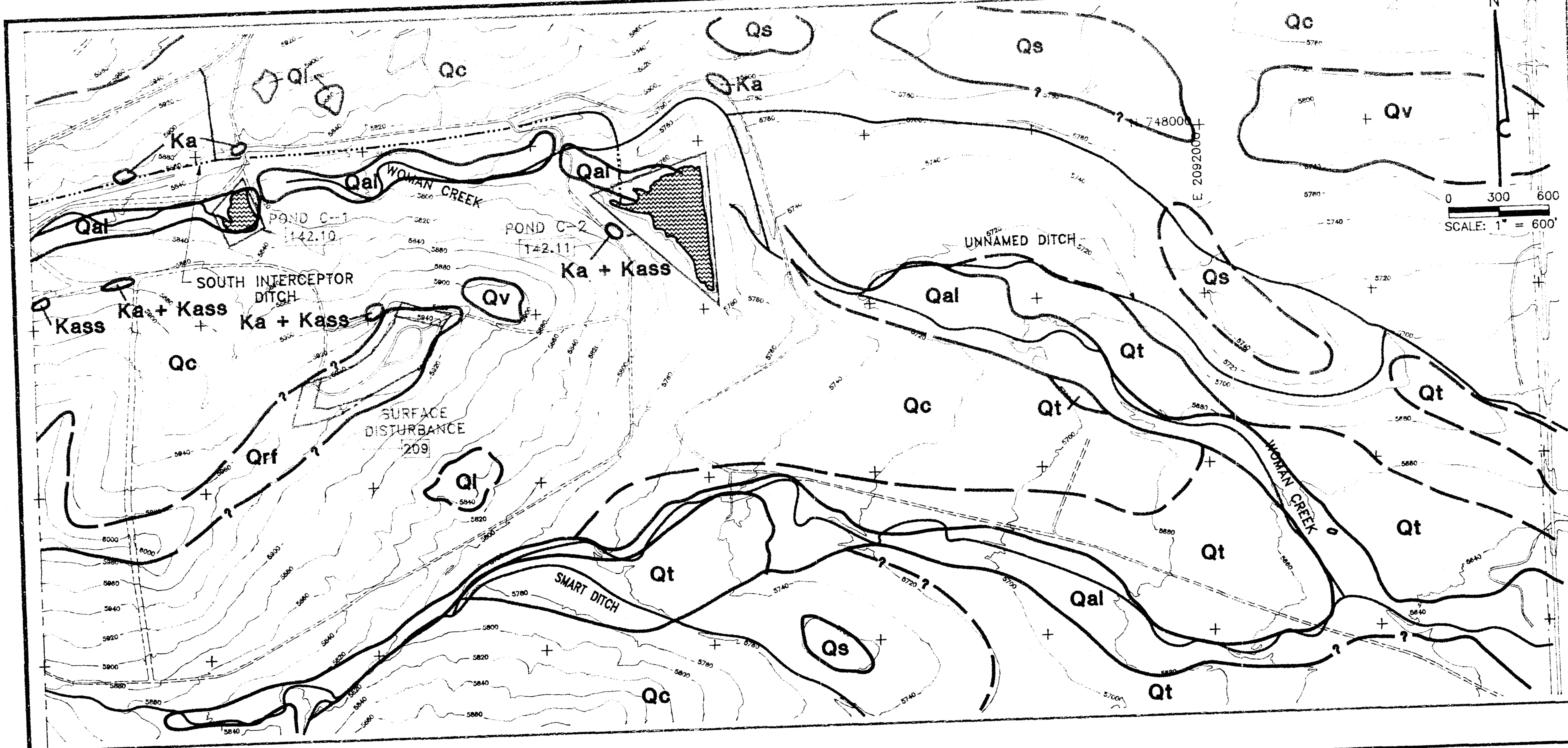
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SURFICIAL GEOLOGY

FIGURE 1-5 (1 OF 2) MARCH 1991

2506001A



MATCHLINE
(SEE FIGURE 1-5 [1 OF 2])

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EXPLANATION

(polygon)	INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5
115	IHSS REFERENCE NUMBER
(dash-dot line)	INTERMITTENT STREAM
(double dashed line)	DIRT ROAD
(long dash line)	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE

CONTACT
—?—? DASHED WHERE APPROXIMATELY LOCATED, QUERIED WHERE INFERRED.

QUATERNARY

Qal	RECENT VALLEY FILL
Ql	LANDSLIDE
Qc	COLLUVIUM
Qt	TERRACE ALLUVIUM
Qs	SLOCUM ALLUVIUM
Qv	VERDOS ALLUVIUM
Qrf	ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass	ARAPAHOE FORMATION, SANDSTONE
Ka	ARAPAHOE FORMATION, CLAYSTONE

SOURCE: EG&G 1990c

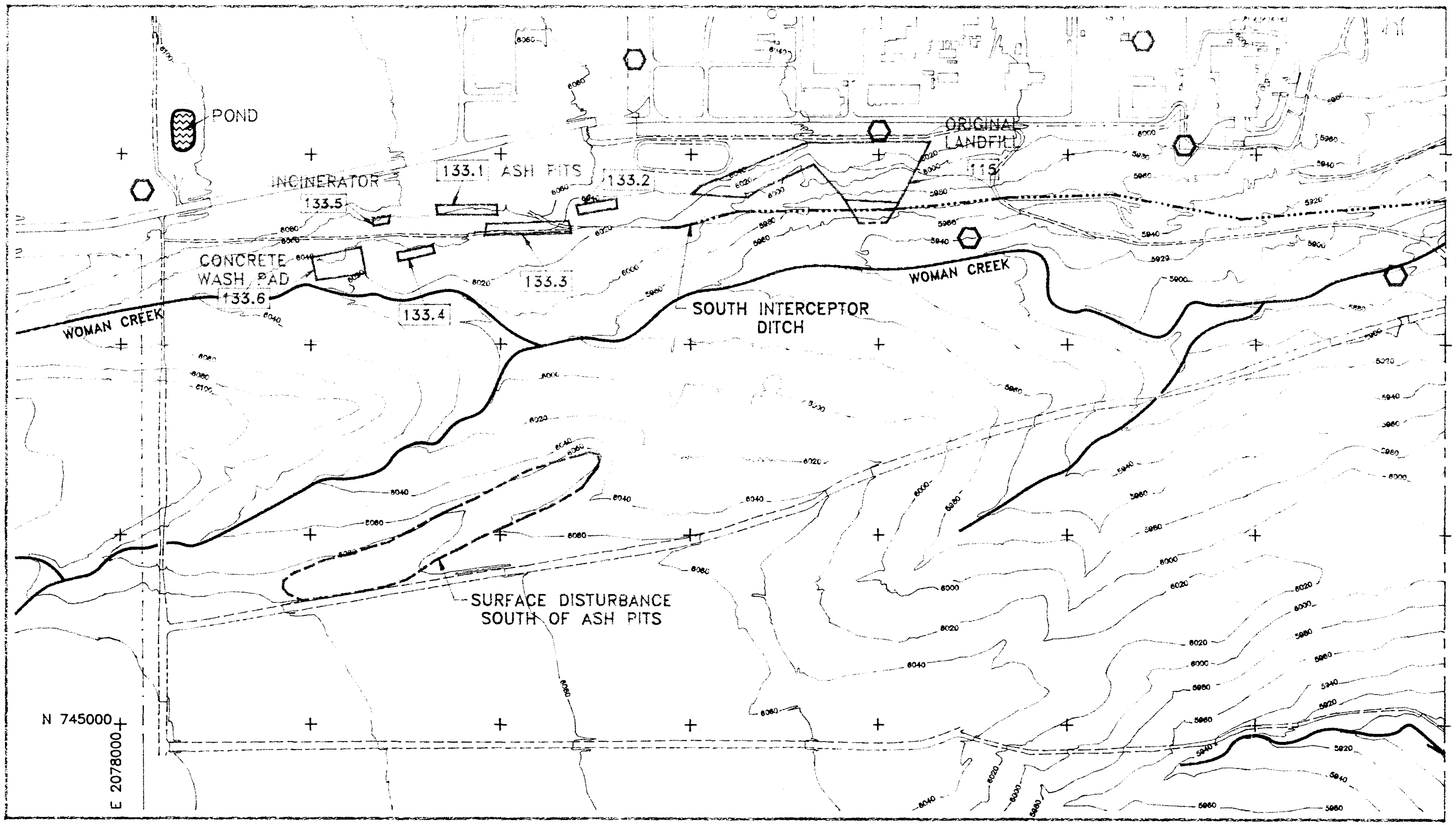
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SURFICIAL GEOLOGY

FIGURE 1-5 (2 of 2) MARCH 1991

2506001B



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EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5
- 115 IHSS REFERENCE NUMBER
- SOUTH INTERCEPTOR DITCH
- DIRT ROAD
- PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
- EXISTING OR PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

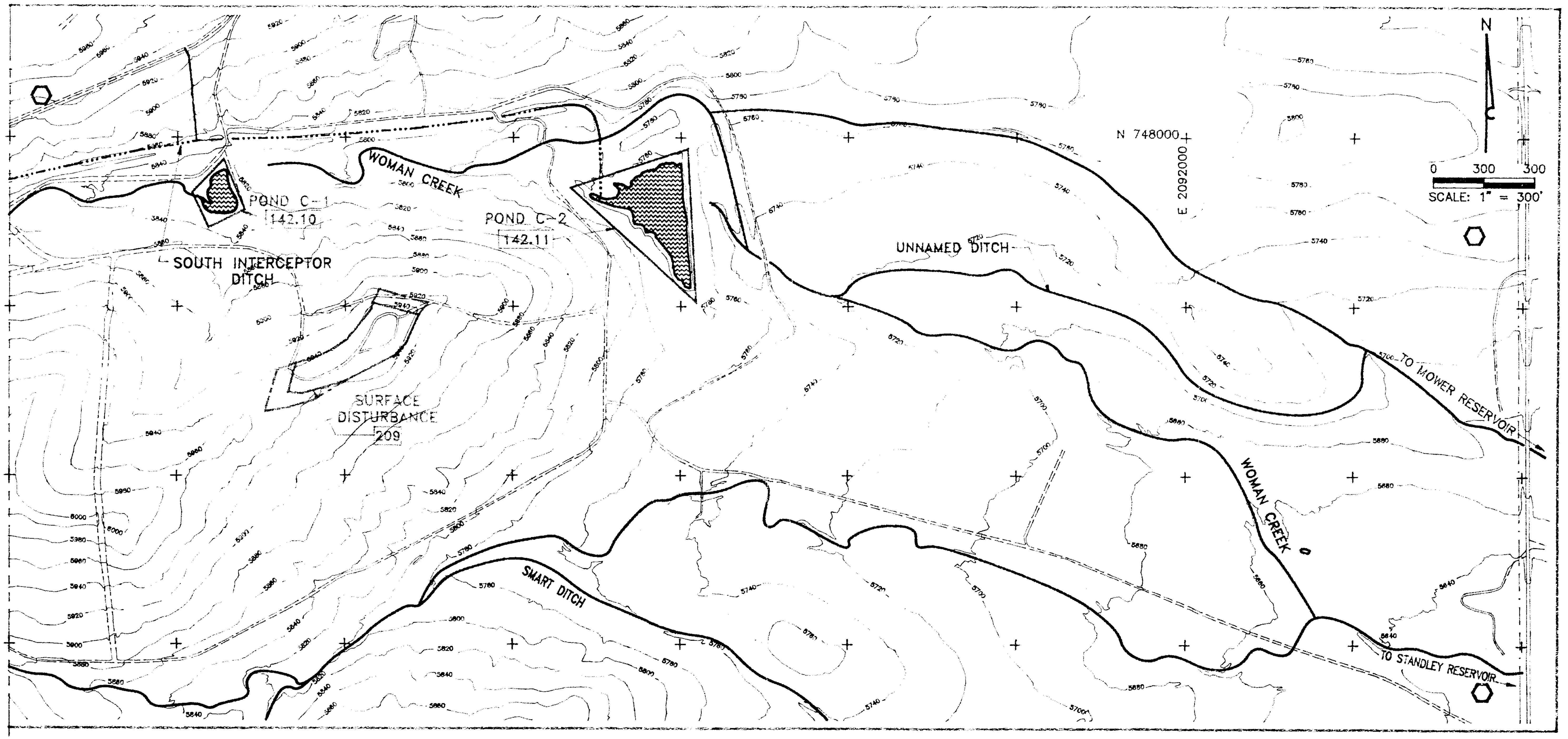
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES

FIGURE 2-1 (1 OF 2) MARCH 1991

25060020



MATCHLINE
(SEE FIGURE 2-1[1 OF 2])

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25060030

EXPLANATION

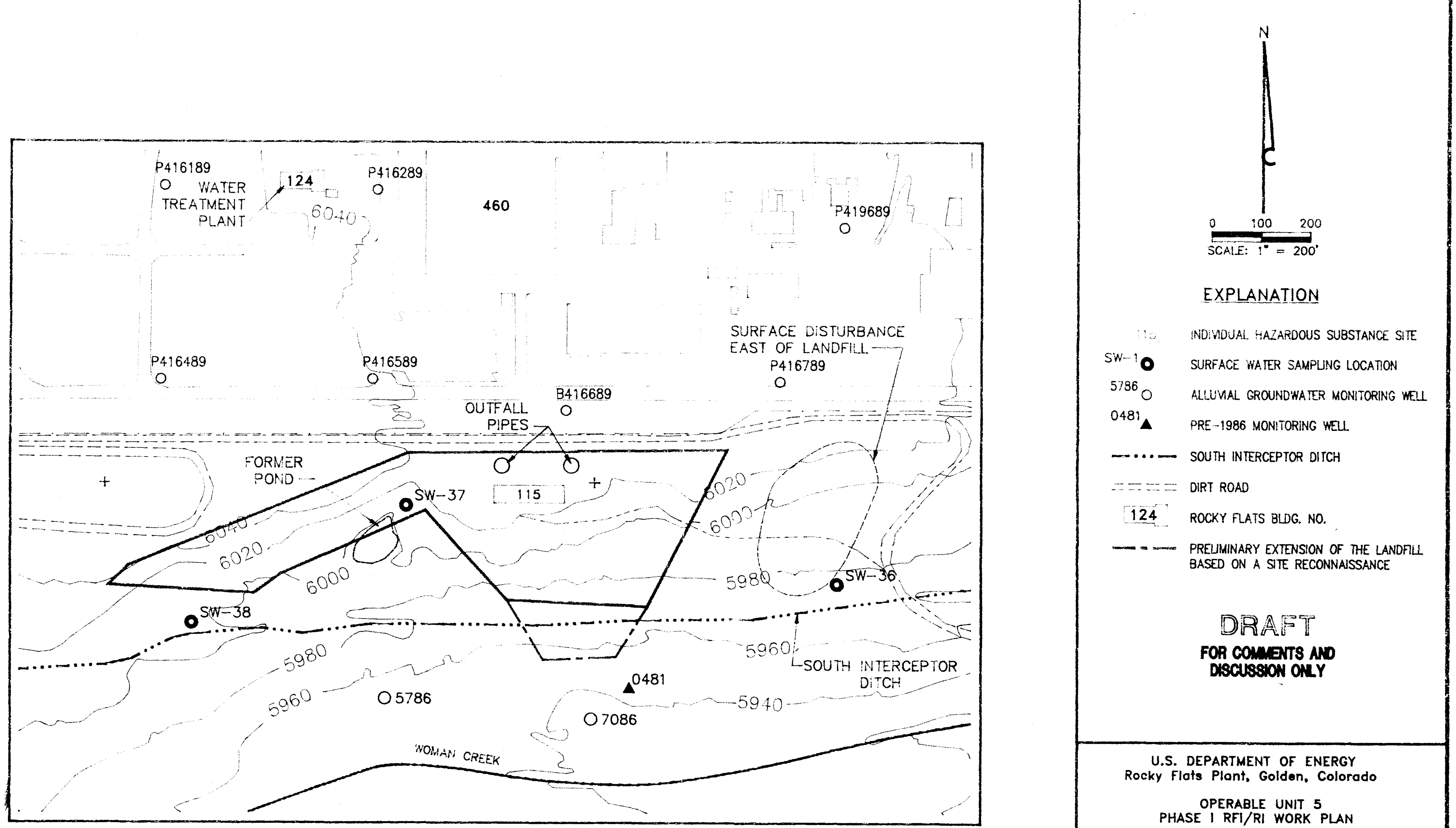
- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5
- 115 IHSS REFERENCE NUMBER
- SOUTH INTERCEPTOR DITCH
- DIRT ROAD
- PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
- EXISTING OR PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES

FIGURE 2-1 (2 OF 2) MARCH 1991



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Rocky Flats Plant, Golden, Colorado

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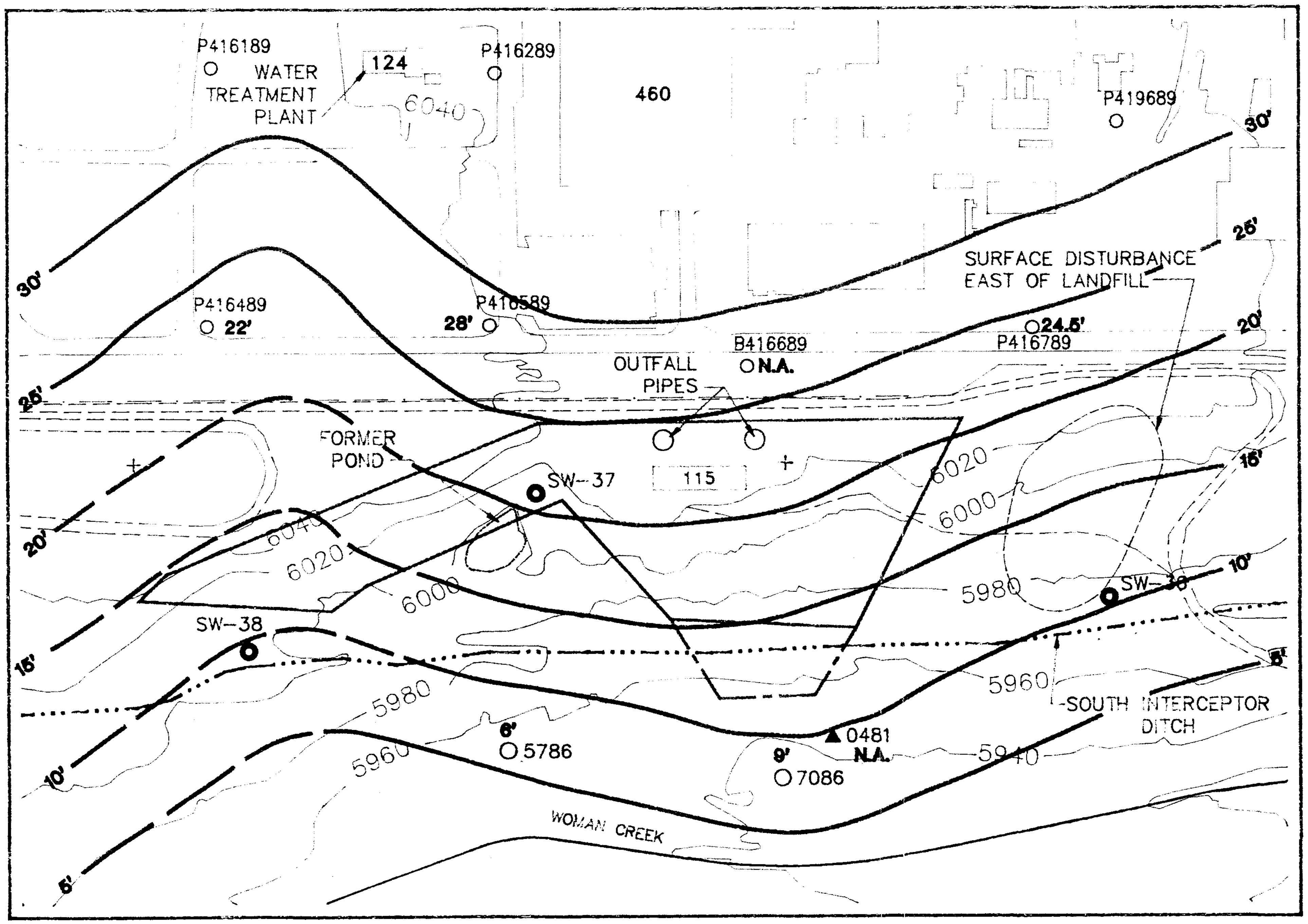
PHASE I RFI/RI WORK PLAN

IHSS 115
ORIGINAL LANDFILL

FIGURE 2-2 MARCH 1991

25060030



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EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	SURFACE WATER SAMPLING LOCATION
5786	ALLUVIAL GROUNDWATER MONITORING WELL
0481	PRE-1986 MONITORING WELL
	SOUTH INTERCEPTOR DITCH
	DIRT ROAD
124	ROCKY FLATS BLDG. NO.
22'	THICKNESS OF COLLUVIUM AND ROCKY FLATS ALLUVIUM
N.A.	NOT AVAILABLE
	PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE
10'	CONTOUR OF EQUAL THICKNESS OF COLLUVIUM AND ROCKY FLATS ALLUVIUM, DASHED WHERE INFERRED

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Rocky Flats Plant, Golden, Colorado

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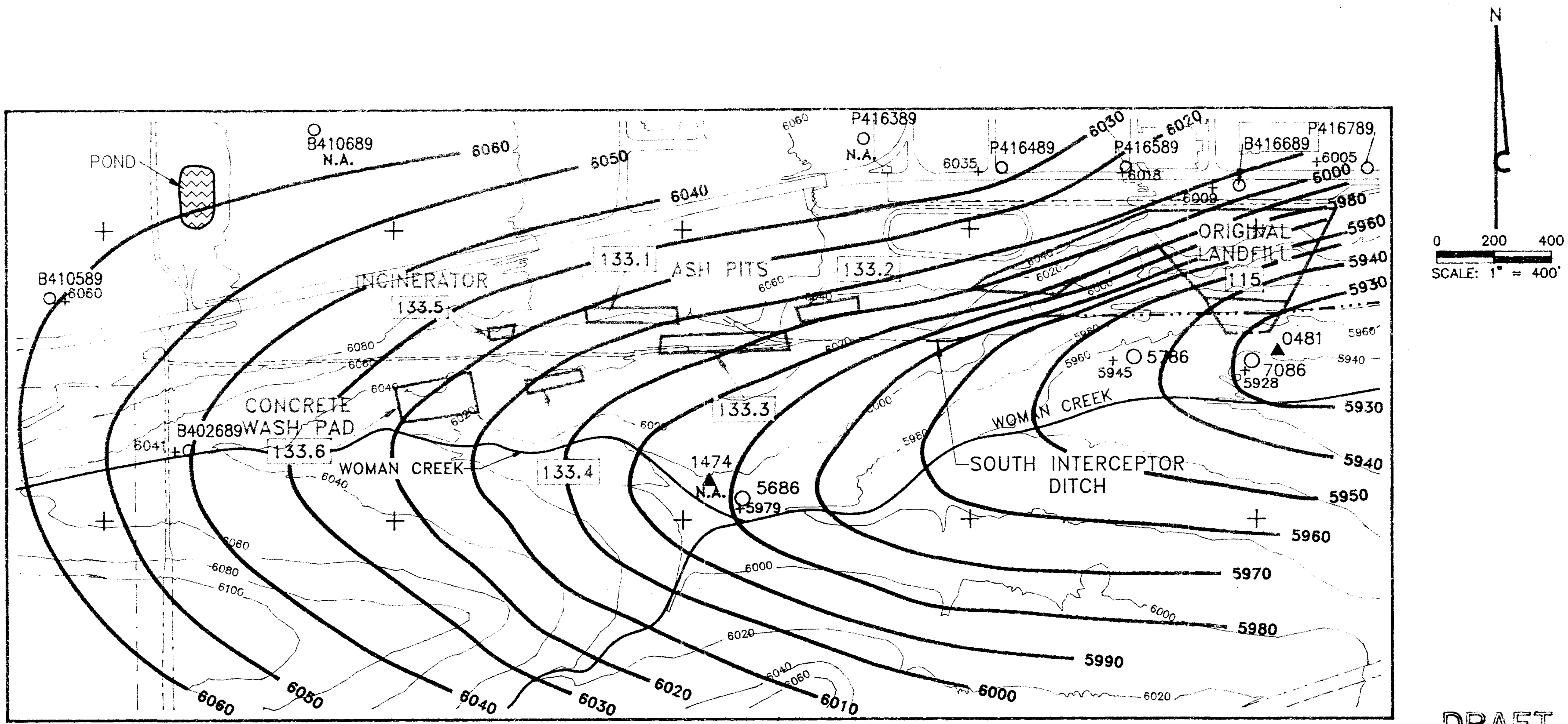
ISOPACH MAP COLLUVIUM AND ROCKY FLATS ALLUVIUM ORIGINAL LANDFILL AREA

FIGURE 2-4 MARCH 1991

25060050



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FOR COMMENTS AND DISCUSSION ONLY

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
5786 ○	ALLUVIAL GROUNDWATER MONITORING WELL
0481 ▲	PRE-1986 MONITORING WELL
+5979	ELEVATION OF STATIC WATER LEVEL (OCTOBER 1990)
—··· —	SOUTH INTERCEPTOR DITCH
=======	DIRT ROAD
— — —	PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE
10'	INFERRED CONTOUR
N.A.	NOT AVAILABLE

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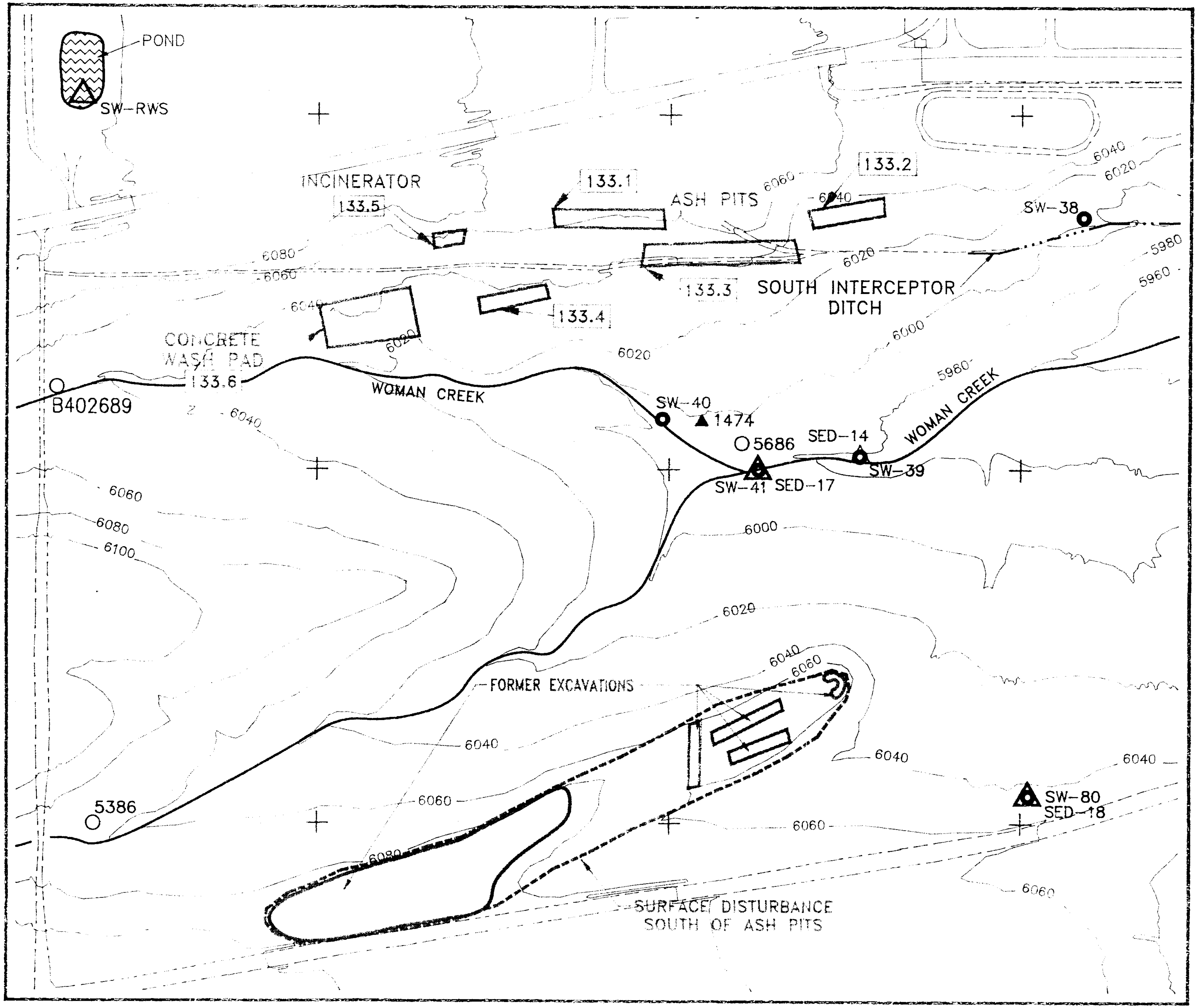
POTENTIOMETRIC MAP OF THE ALLUVIAL AQUIFER

FIGURE 2–5 MARCH 1991

25060060



N

0 150 300
SCALE: 1" = 300'

EXPLANATION

- 133 INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 SURFACE WATER SAMPLING LOCATION
- 5786 ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 SEDIMENT SAMPLING LOCATION
- 1474 PRE-1986 MONITORING WELL
- SOUTH INTERCEPTOR DITCH
- DIRT ROAD

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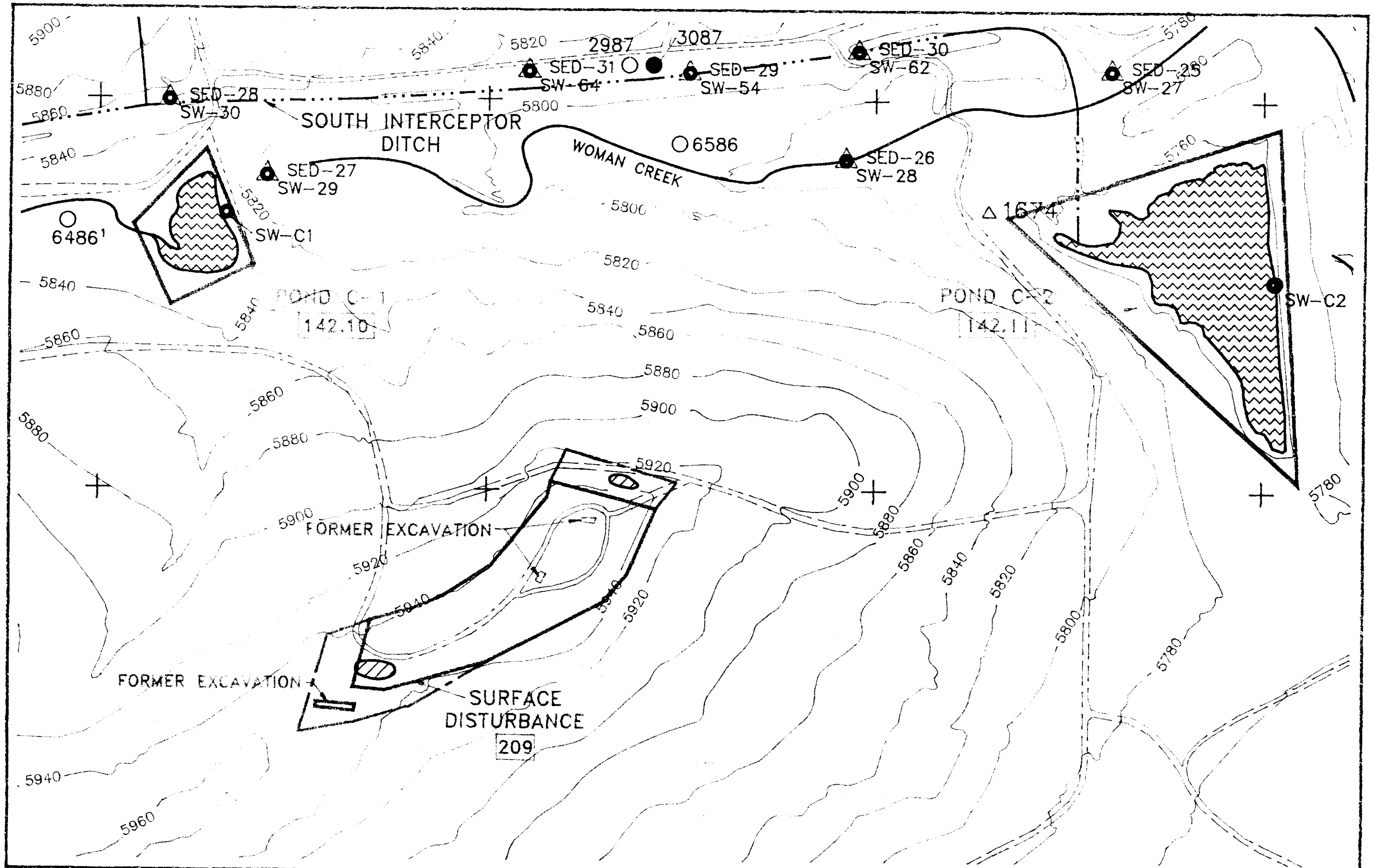
IHSS 133.1-6,
ASH PITS 1-4, INCINERATOR,
CONCRETE WASH PAD, AND ADDITIONAL
SURFACE DISTURBANCES SOUTH OF
ASH PIT AREA

FIGURE 2-6 MARCH 1991

25060070



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N

0 150 300
SCALE: 1" = 300'

EXPLANATION

- 115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 EXISTING SEDIMENT SAMPLING LOCATION
- 3087 EXISTING BEDROCK GROUNDWATER MONITORING WELL
- PONDLIKE DEPRESSION
- SOUTH INTERCEPTOR DITCH
- DIRT ROAD
- PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A SITE RECONNAISSANCE

NOTE: [1] LOCATION IS APPROXIMATELY 300 FEET TO THE WEST

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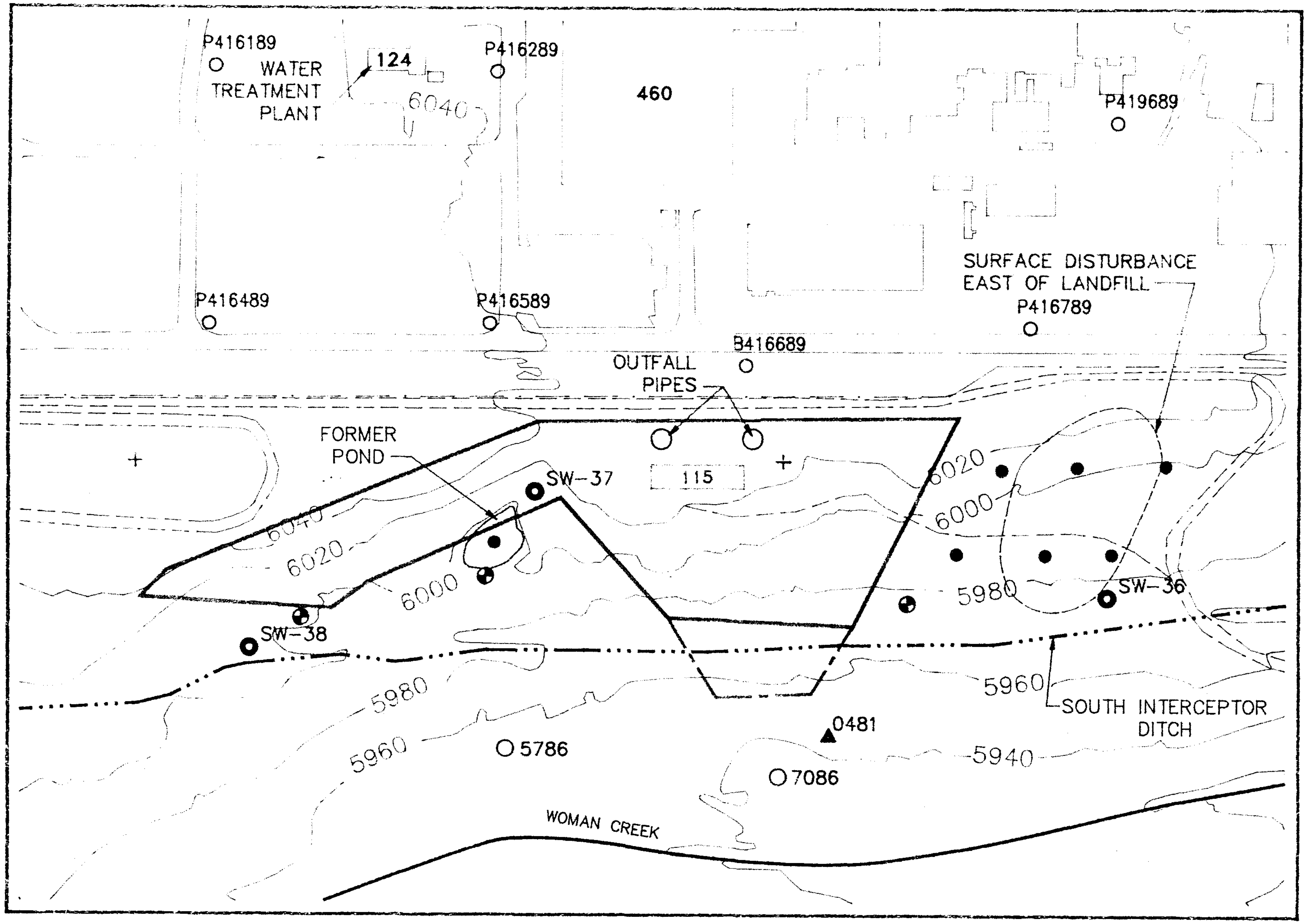
IHSS 142.10-11
PONDS C-1 AND C-2
AND IHSS 209 SURFACE
DISTURBANCE

FIGURE 2-7 MARCH 1991

25060080



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N

0 100 200
SCALE: 1" = 200'

EXPLANATION

115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1 SURFACE WATER SAMPLING LOCATION
5786 ALLUVIAL GROUNDWATER MONITORING WELL
0481 PRE-1986 MONITORING WELL
SOUTH INTERCEPTOR DITCH
DIRT ROAD
124 ROCKY FLATS BLDG. NO.
PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE
PROPOSED WELL LOCATION*
PROPOSED SOIL BORING LOCATION*

*ALL PROPOSED LOCATIONS ARE APPROXIMATE

FOR SEDIMENT AND SURFACE WATER LOCATIONS, SEE FIGURE 7-4

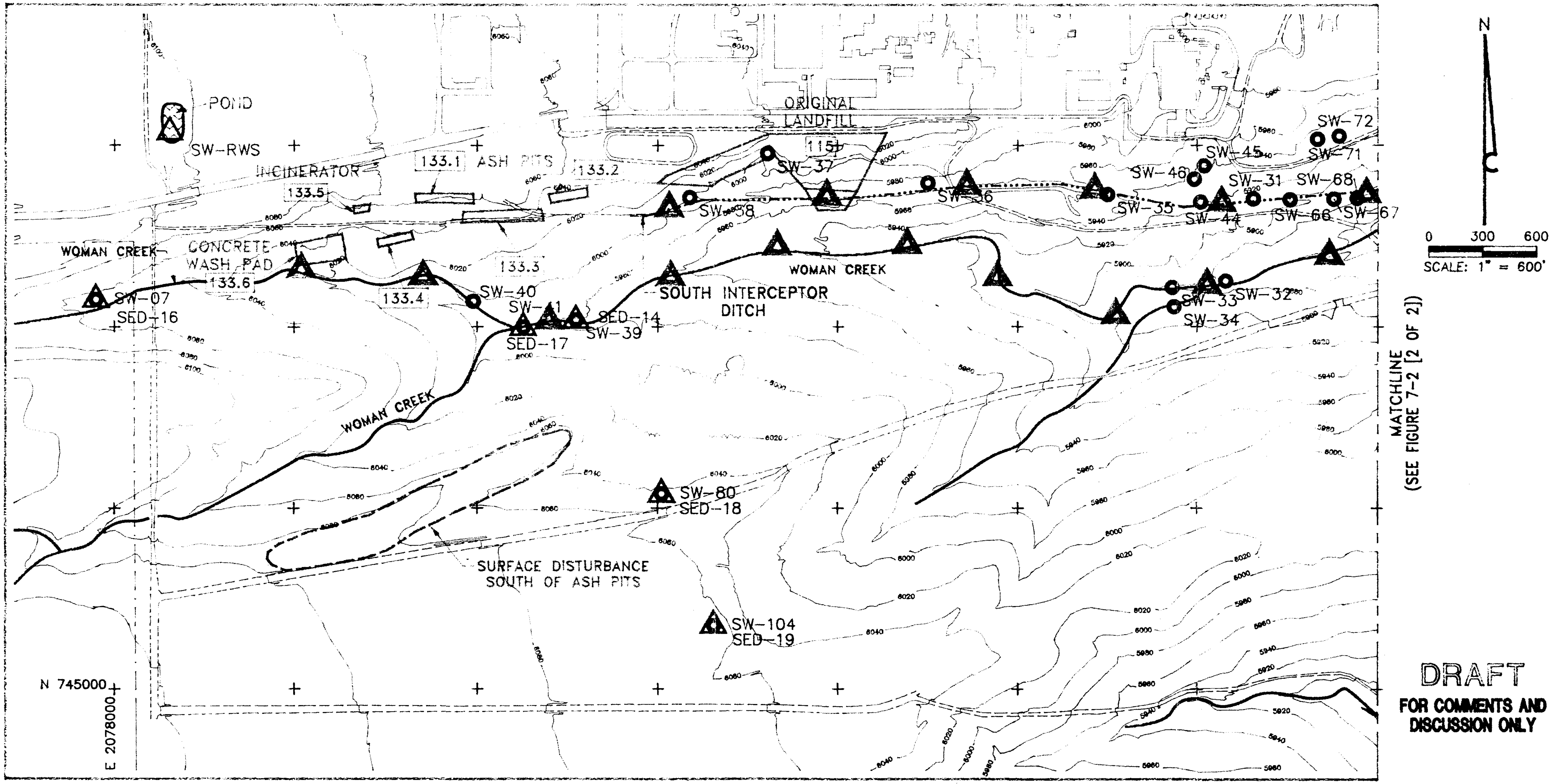
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING AND WELL LOCATIONS IHSS 115 ORIGINAL LANDFILL

FIGURE 7-1 MARCH 1991

25060090



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EXPLANATION

115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE

SW-1 EXISTING SURFACE WATER LOCATION

SED-1 EXISTING SEDIMENT SAMPLING LOCATION

SOUTH INTERCEPTOR DITCH

DIRT ROAD

PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE

PROPOSED LOCATIONS FOR SEDIMENT SAMPLES

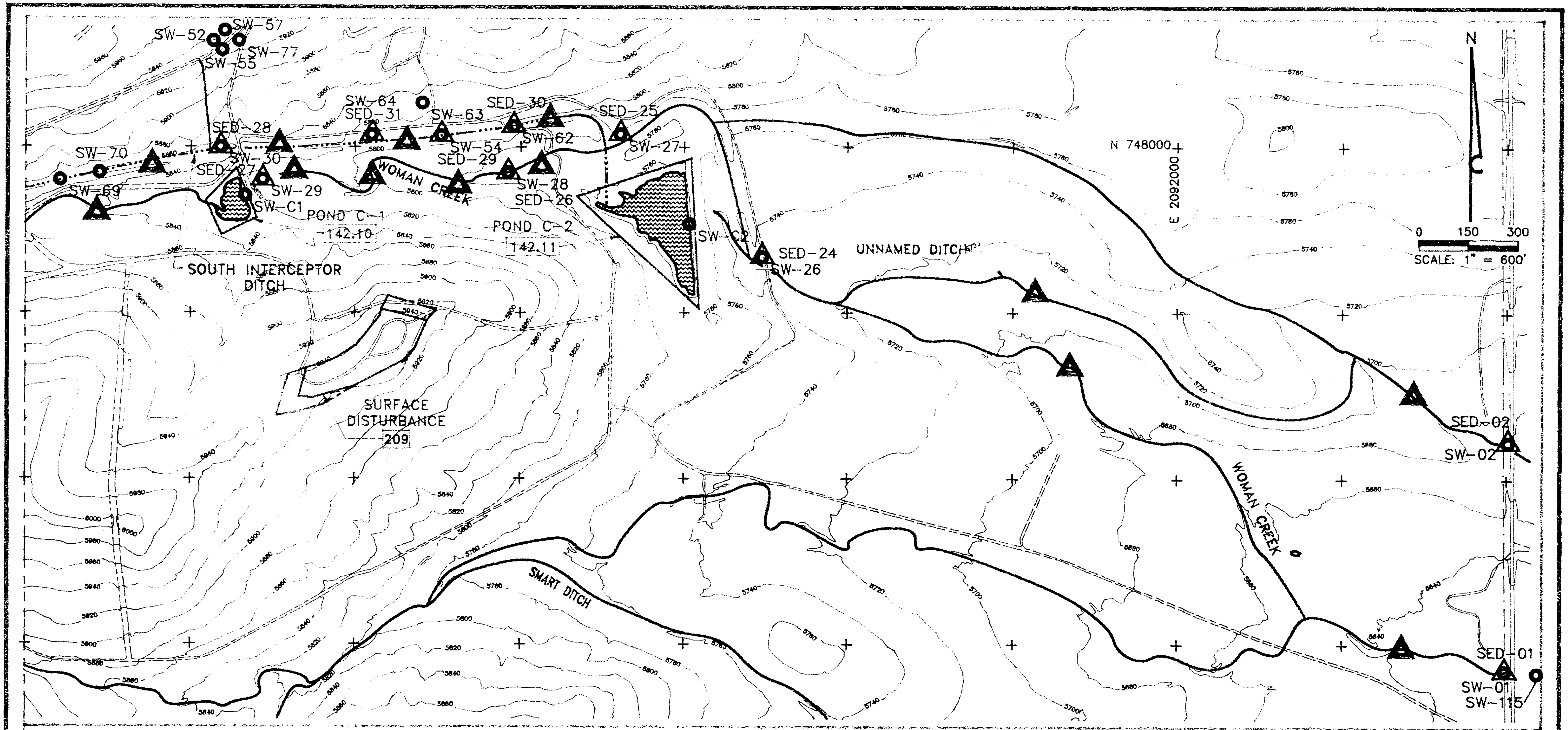
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SEDIMENT SAMPLING SITES
WOMAN CREEK AND THE SOUTH
INTERCEPTOR DITCH

FIGURE 7-2 (1 OF 2) MARCH 1991

2506010A



MATCHLINE
(SEE FIGURE 7-2 [1 OF 2])

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EXPLANATION

115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE

SW-1 EXISTING SURFACE WATER LOCATION

SED-1 EXISTING SEDIMENT SAMPLING LOCATION

INTERMITTENT STREAM

DIRT ROAD

PROPOSED APPROXIMATE LOCATIONS FOR SEDIMENT SAMPLES

PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE

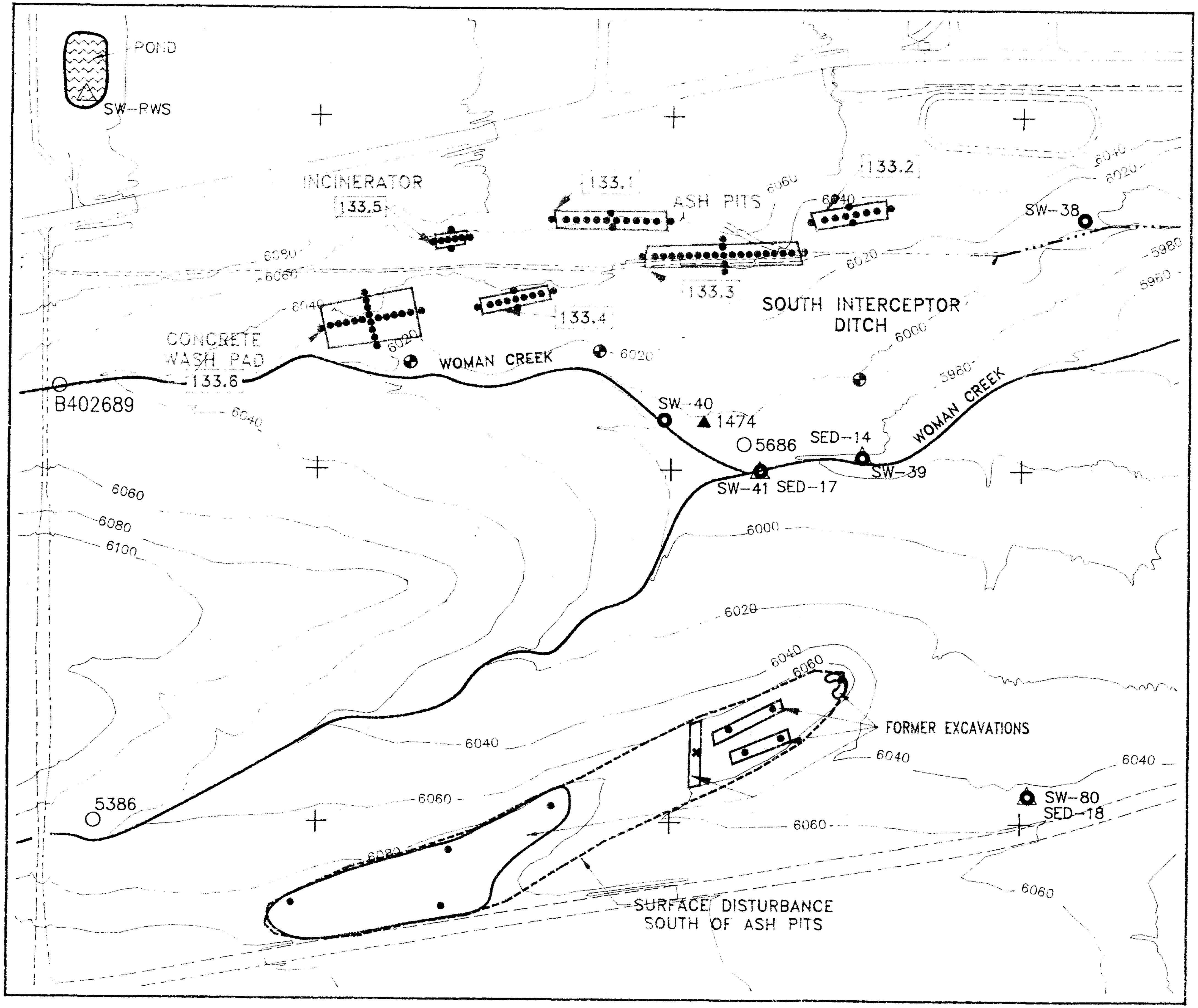
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SEDIMENT SAMPLING SITES
WOMAN CREEK AND THE SOUTH INTERCEPTOR DITCH

FIGURE 7-2 (2 OF 2) MARCH 1991

250601OB



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N

0 150 300
SCALE: 1" = 300'

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
1474	PRE-1986 MONITORING WELL
	PROPOSED SOIL BORING LOCATION [1]
	PROPOSED WELL LOCATION
	PROPOSED SURFACE SAMPLING LOCATION
	SOUTH INTERCEPTOR DITCH
	DIRT ROAD

*ALL PROPOSED LOCATIONS ARE APPROXIMATE

NOTE: [1] LOCATION MAY BE MODIFIED BASED ON RESULTS OF VISUAL INSPECTION AND RADIATION SURVEY.

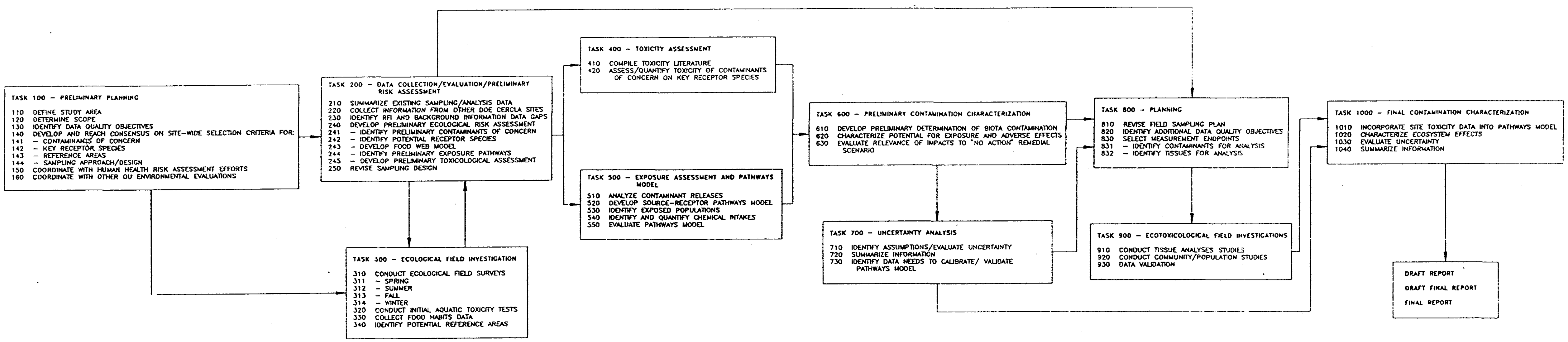
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS
IHSS 133.1-6,
ASH PITS 1-4, INCINERATOR,
CONCRETE WASH PAD, AND ADDITIONAL
SURFACE DISTURBANCE

FIGURE 7-3 MARCH 1991

25060110



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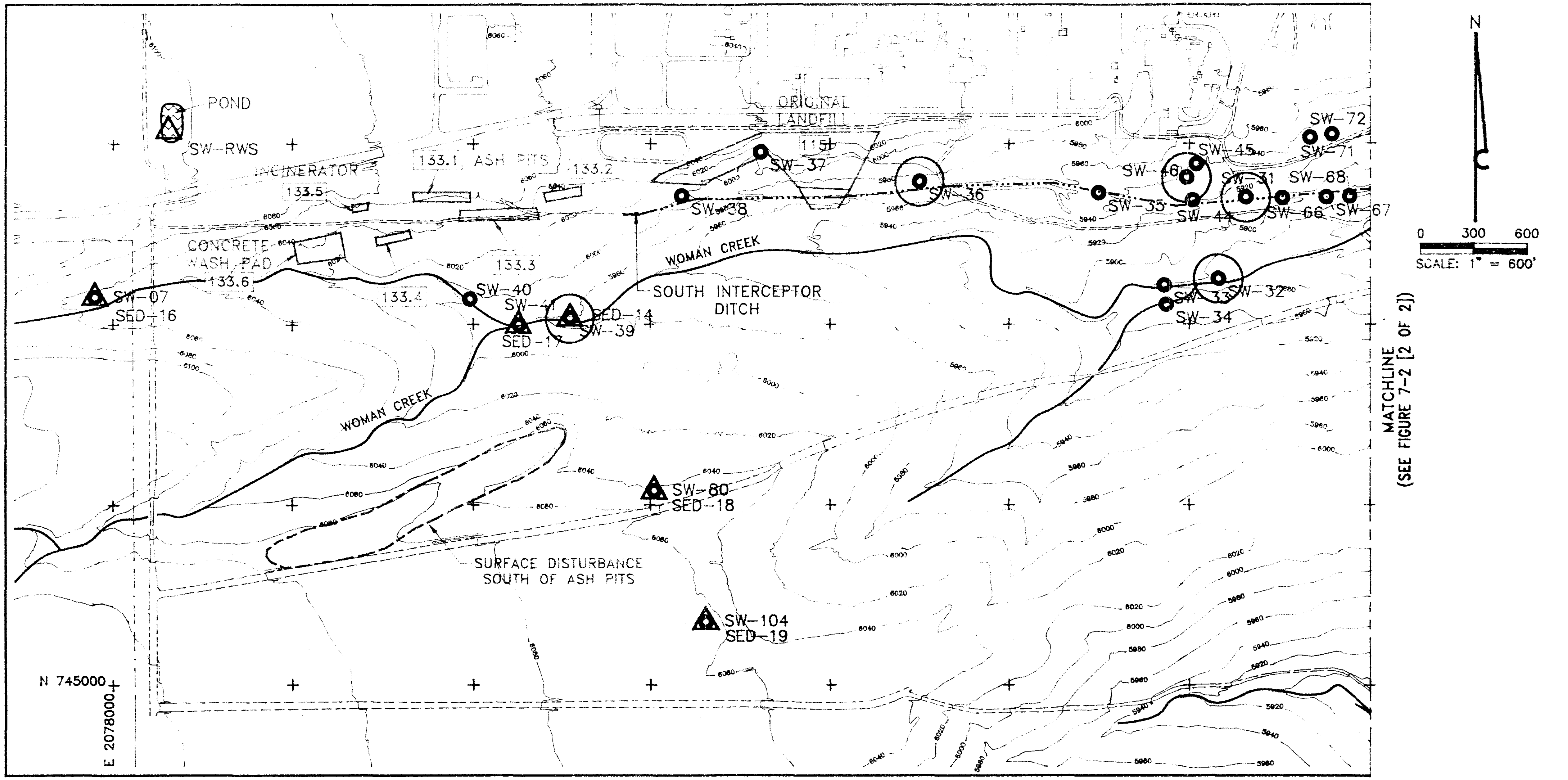
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

FLOW DIAGRAM:
INTERRELATIONSHIPS BETWEEN TASKS

FIGURE 9–1 MARCH 1991



EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
	SOUTH INTERCEPTOR DITCH
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
	SAMPLING LOCATIONS FOR AQUATIC BIOTA

DRAFT
FOR COMMENTS AND DISCUSSION ONLY

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND AQUATIC SAMPLING LOCATIONS

FIGURE 9-3 (1 OF 2) MARCH 1991

MATCHLINE
(SEE FIGURE 7-2 [1 OF 2])

EXPLANATION

- 115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 EXISTING SURFACE WATER LOCATION
- SED-1 EXISTING SEDIMENT SAMPLING LOCATION
- INTERMITTENT STREAM
- DIRT ROAD
- SAMPLING LOCATIONS FOR AQUATIC BIOTA
- PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE

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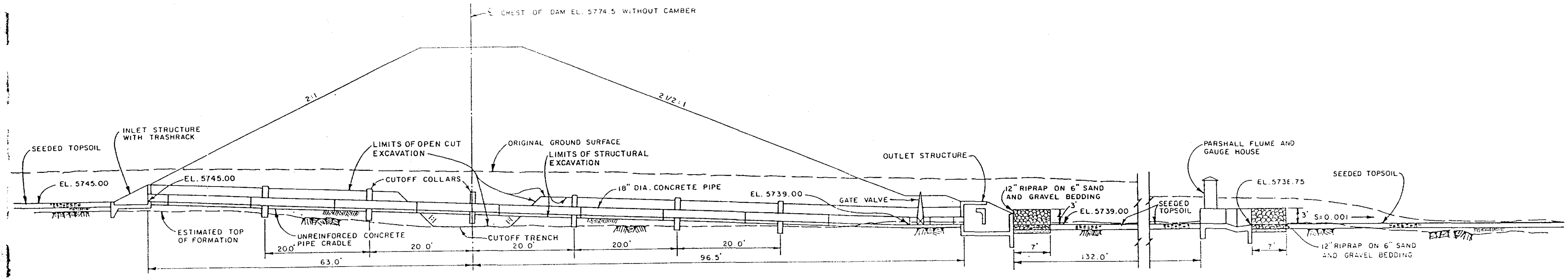
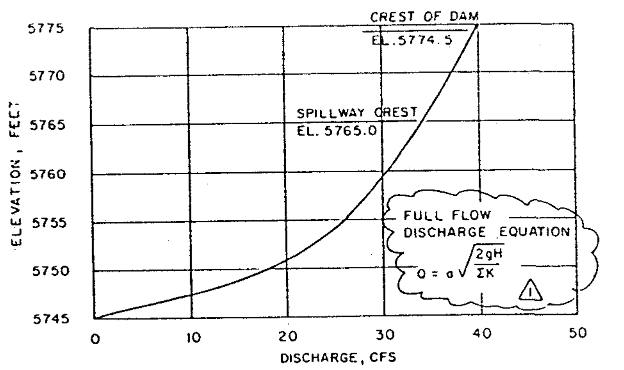
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND AQUATIC SAMPLING LOCATIONS

FIGURE 9-3 (2 OF 2) MARCH 1991



SECTION - ℄ OUTLET WORKS



OUTLET WORKS DISCHARGE CURVE

SYMBOLS

Q = DISCHARGE - C.F.S.
a = PIPE AREA - FT^2
g = ACCELERATION OF GRAVITY-FEET/SEC^2
H = HEAD-FEET, MEASURED FROM OUTLET ELEVATION
ΣK = SUMMATION OF FLOW LOSS FACTORS

NOTES

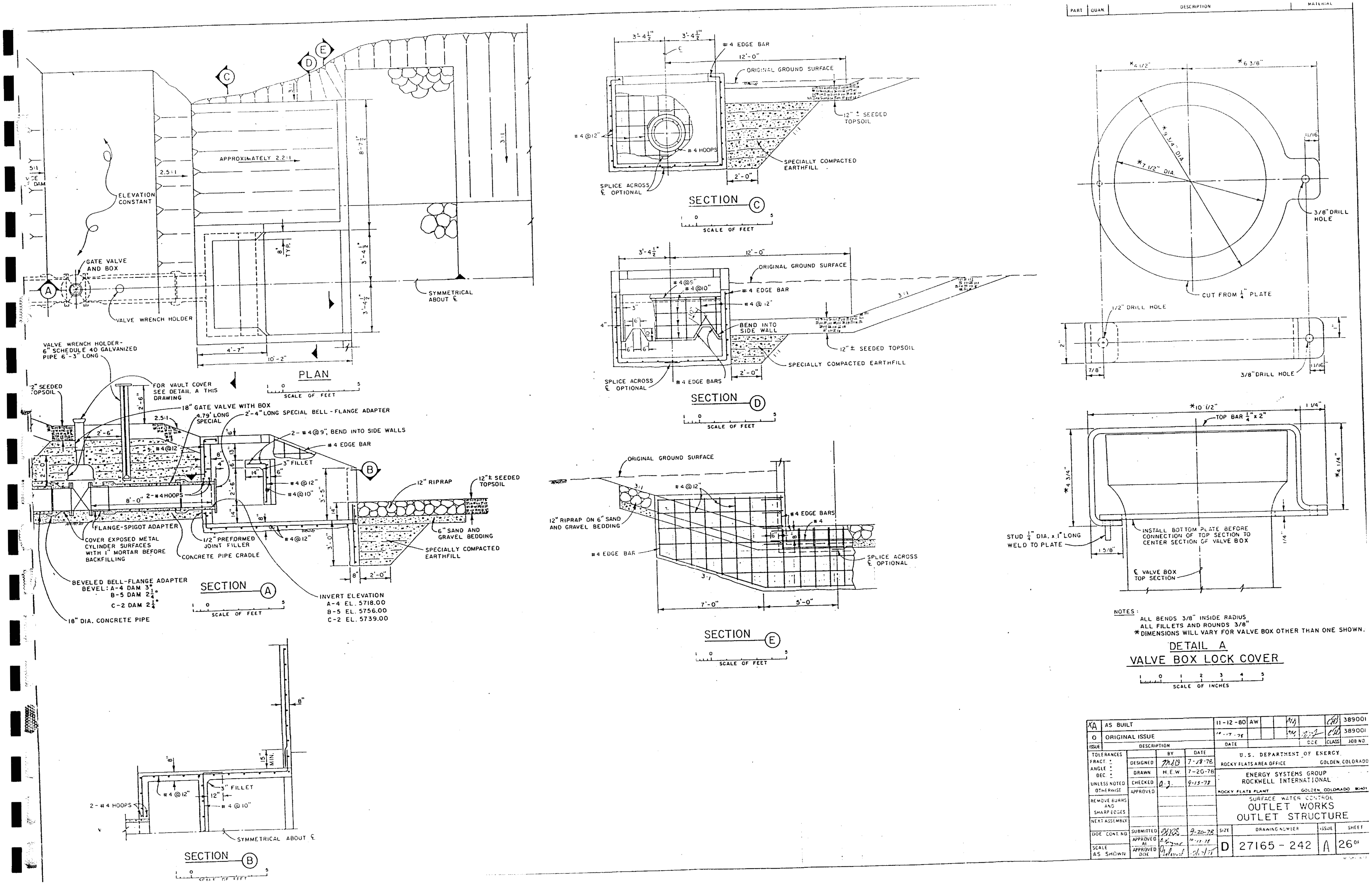
1. SEE DRAWING 27165-232 FOR LOCATION OF THE OUTLET WORKS.
2. SEE DRAWINGS 27165 - 241 AND 242 FOR INLET, PIPE AND OUTLET STRUCTURE DETAILS.
3. SEE DRAWING 27165 - 243 FOR PARSHALL FLUME DETAILS.

ISSUE	DESCRIPTION	DATE				DOE	CLASS	JOB NO
A	AS BUILT	11-12-80	AW					389001
1	CHANGED OUTLET WORKS DISCHARGE EQUATION	11-16-78	MSD			RL7		389001
0	ORIGINAL ISSUE	10-17-78						389001

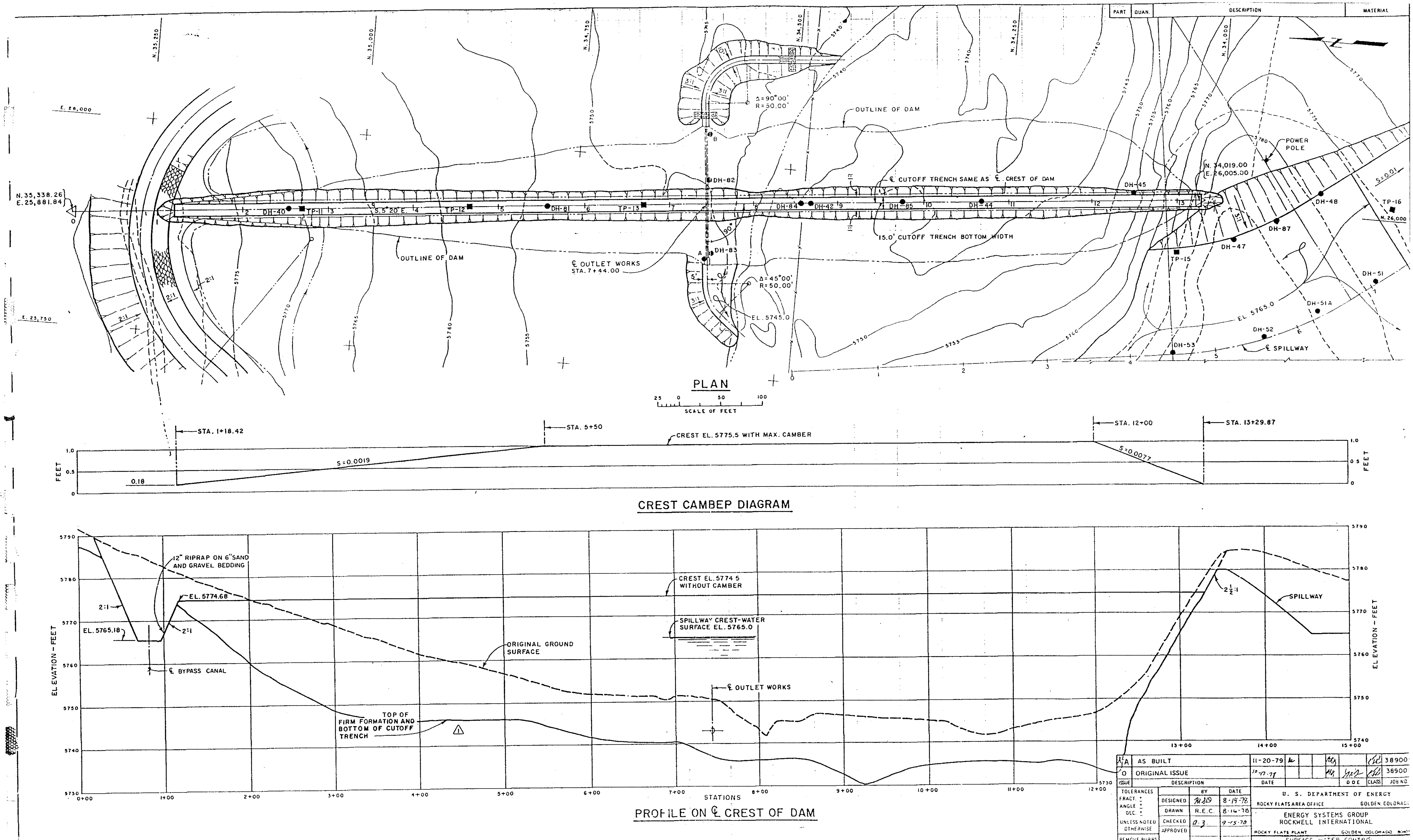
		BY	DATE
TOLERANCES FRACT ± ANGLE ± DEC ±	DESIGNED	MJB	8-3-78
	DRAWN	H.E.W.	8-8-78
UNLESS NOTED OTHERWISE	CHECKED	A J	9-15-78
	APPROVED		
REMOVE BURRS AND SHARP EDGES			
NEXT ASSEMBLY			
DOE CONT NO	SUBMITTED		9-20-78
	APPROVED AI		10-17-78
SCALE AS SHOWN	APPROVED DOE		10/17/78

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN, COLORADO 80401
SURFACE WATER CONTROL
C-2 DAM-OUTLET WORKS

SIZE	DRAWING NUMBER	ISSUE	SHEET
D	27165-236	A	23 OF



PART
QUAN.
DESCRIPTION
MATERIAL
PLAN
SCALE OF FEET
ELEVATION CONSTANT
GATE VALVE AND BOX
VALVE WRENCH HOLDER
APPROXIMATELY 2.2:1
SYMMETRICAL ABOUT ℄
VALVE WRENCH HOLDER-6" SCHEDULE 40 GALVANIZED PIPE 6'-3" LONG
FOR VAULT COVER SEE DETAIL A THIS DRAWING
18" GATE VALVE WITH BOX
4.79' LONG SPECIAL
2'-4" LONG SPECIAL BELL-FLANGE ADAPTER
2-#4@9", BEND INTO SIDE WALLS
#4 EDGE BAR
3" FILLET
12" RIPRAP
12"± SEEDED TOPSOIL
6" SAND AND GRAVEL BEDDING
SPECIALLY COMPACTED EARTHFILL
FLANGE-SPIGOT ADAPTER
COVER EXPOSED METAL CYLINDER SURFACES WITH 1" MORTAR BEFORE BACKFILLING
1/2" PREFORMED JOINT FILLER
CONCRETE PIPE CRADLE
BEVELED BELL-FLANGE ADAPTER BEVEL: A-4 DAM 3° B-5 DAM 2¼° C-2 DAM 2¼°
18" DIA. CONCRETE PIPE
SECTION A
INVERT ELEVATION
A-4 EL. 5718.00
B-5 EL. 5756.00
C-2 EL. 5739.00
SECTION B
2-#4 HOOPS
SYMMETRICAL ABOUT ℄
SECTION C
ORIGINAL GROUND SURFACE
SPLICE ACROSS ℄ OPTIONAL
SECTION D
BEND INTO SIDE WALL
#4 EDGE BARS
SECTION E
12" RIPRAP ON 6" SAND AND GRAVEL BEDDING
CUT FROM ¼" PLATE
3/8" DRILL HOLE
1/2" DRILL HOLE
TOP BAR ¼" x 2"
STUD ¼" DIA. x 1" LONG WELD TO PLATE
INSTALL BOTTOM PLATE BEFORE CONNECTION OF TOP SECTION TO CENTER SECTION OF VALVE BOX
℄ VALVE BOX TOP SECTION
NOTES:
ALL BENDS 3/8" INSIDE RADIUS
ALL FILLETS AND ROUNDS 3/8"
*DIMENSIONS WILL VARY FOR VALVE BOX OTHER THAN ONE SHOWN.
DETAIL A
VALVE BOX LOCK COVER
SCALE OF INCHES
A AS BUILT 11-12-80 AW 389001
0 ORIGINAL ISSUE 389001
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN, COLORADO
SURFACE WATER CONTROL
OUTLET WORKS
OUTLET STRUCTURE
DESIGNED 7-18-76
DRAWN H.E.W. 7-20-76
CHECKED 9-15-78
SUBMITTED 9-20-78
SCALE AS SHOWN
D 27165-242 A 26

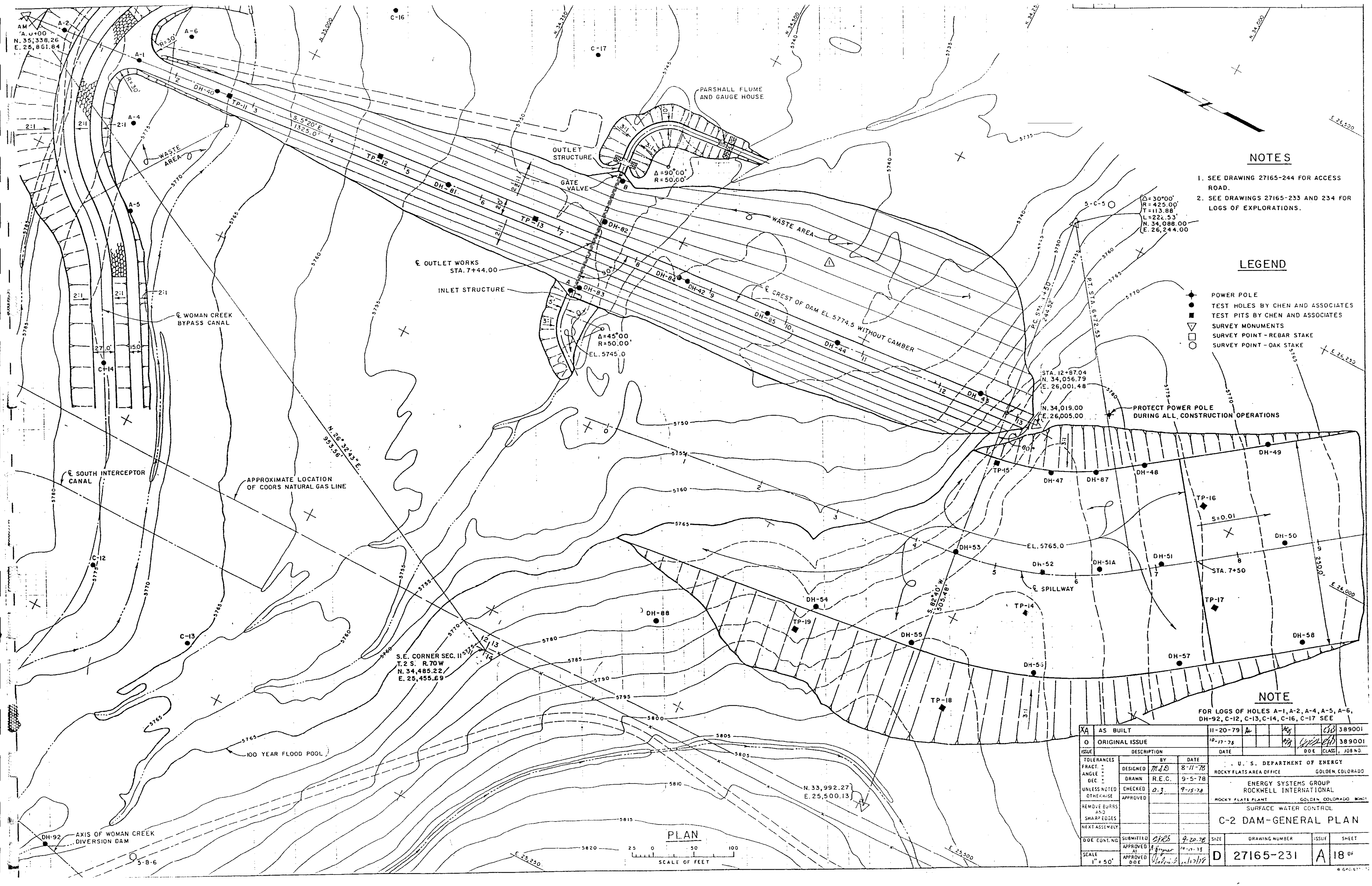


Issue	Description	Date		
A	AS BUILT	11-20-79		38900
0	ORIGINAL ISSUE	10-17-79		38900

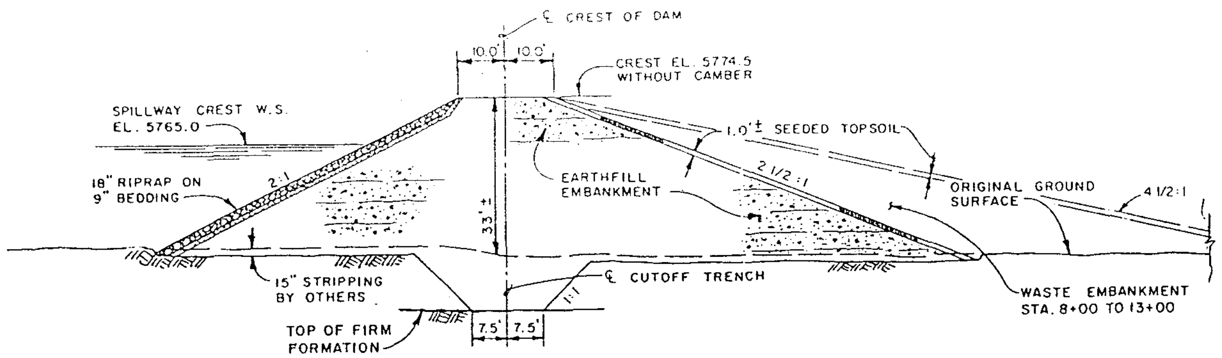
	BY	DATE
DESIGNED		8-14-78
DRAWN	R.E.C.	8-14-78
CHECKED		9-15-78
APPROVED		
SUBMITTED		9-20-78
APPROVED AI		
APPROVED DOE		

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN COLORADO
SURFACE WATER CONTROL
C-2 DAM-CUTOFF TRENCH
PLAN AND DAM PROFILE

SCALE AS SHOWN
SIZE D DRAWING NUMBER 27165-232 ISSUE A SHEET 19

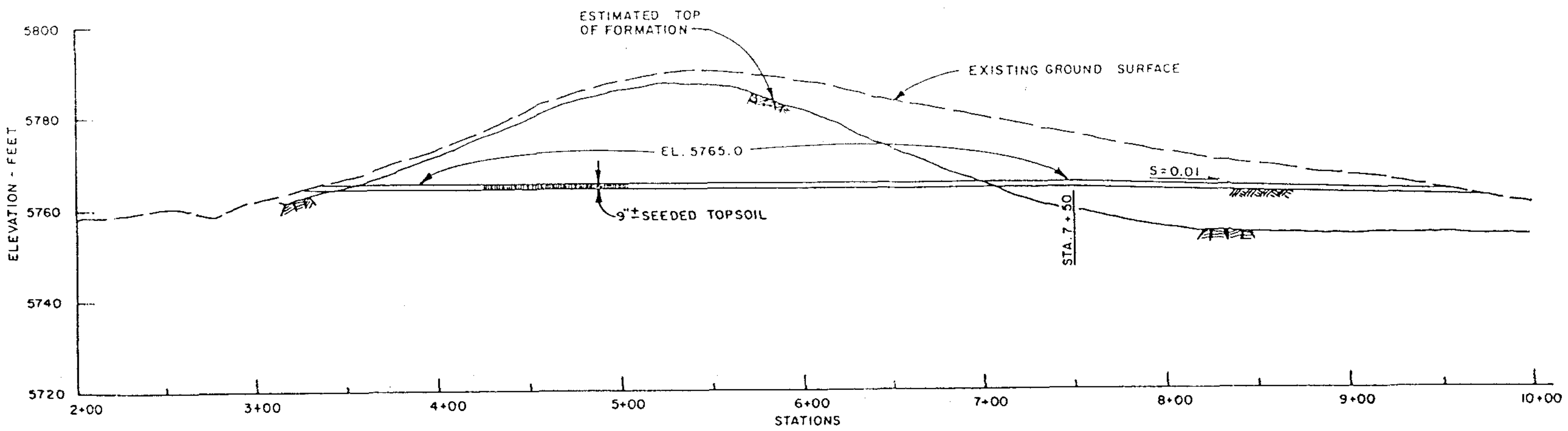

NOTES
1. SEE DRAWING 27165-244 FOR ACCESS ROAD.
2. SEE DRAWINGS 27165-233 AND 234 FOR LOGS OF EXPLORATIONS.
LEGEND
POWER POLE
TEST HOLES BY CHEN AND ASSOCIATES
TEST PITS BY CHEN AND ASSOCIATES
SURVEY MONUMENTS
SURVEY POINT - REBAR STAKE
SURVEY POINT - OAK STAKE
NOTE
FOR LOGS OF HOLES A-1, A-2, A-4, A-5, A-6, DH-92, C-12, C-13, C-14, C-16, C-17 SEE
PARSHALL FLUME AND GAUGE HOUSE
OUTLET STRUCTURE
GATE VALVE
℄ OUTLET WORKS STA. 7+44.00
INLET STRUCTURE
WASTE AREA
℄ CREST OF DAM EL. 5774.5 WITHOUT CAMBER
℄ WOMAN CREEK BYPASS CANAL
℄ SOUTH INTERCEPTOR CANAL
APPROXIMATE LOCATION OF COORS NATURAL GAS LINE
100 YEAR FLOOD POOL
AXIS OF WOMAN CREEK DIVERSION DAM
PROTECT POWER POLE DURING ALL CONSTRUCTION OPERATIONS
℄ SPILLWAY
EL. 5765.0
STA. 7+50
S=0.01
250.0'
S.E. CORNER SEC. 11 T.2 S. R.70W N. 34,485.22 E. 25,455.69
N. 26° 32' 43" E. 953.56'
S. 82° 40' W. 505.48'
S. 5° 20' E. 1325.0'
STA. 12+87.04 N. 34,056.79 E. 26,001.48
N. 34,019.00 E. 26,005.00
Δ=30°00' R=425.00' T=113.88 L=222.53' N. 34,088.00 E. 26,244.00
PT. STA. 6+72.53
PC STA. 4+50
Δ=90°00' R=50.00'
Δ=45°00 R=50.00'
EL. 5745.0
AM A.0+00 N. 35,338.26 E. 25,861.84
N. 33,992.27 E. 25,500.13
PLAN
SCALE OF FEET
XA AS BUILT 11-20-79 389001
0 ORIGINAL ISSUE 10-17-78 389001
U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN, COLORADO
SURFACE WATER CONTROL
C-2 DAM-GENERAL PLAN
DESIGNED MJD 8-11-78
DRAWN R.E.C. 9-5-78
CHECKED 9-15-78
SCALE 1" = 50'
D 27165-231 A 18

PART	QUAN.	DESCRIPTION	MATERIAL

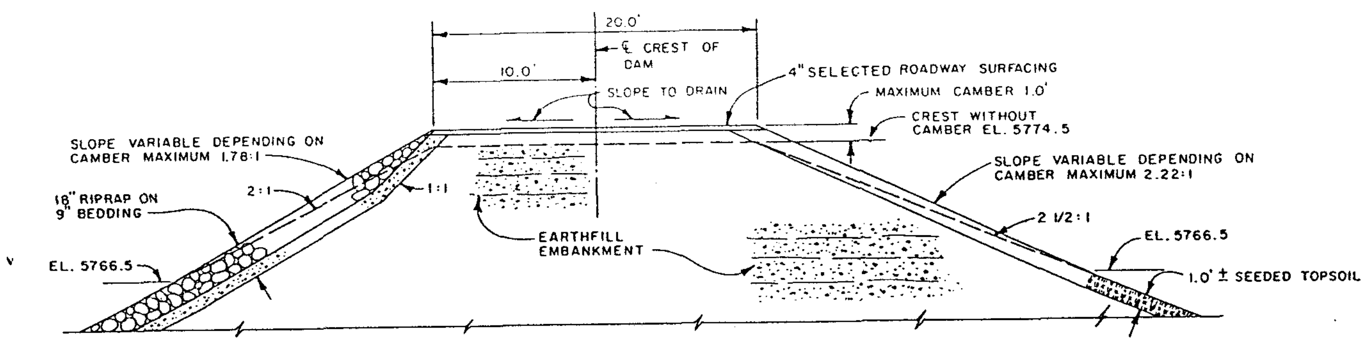


MAXIMUM SECTION

10 0 20 40 60
SCALE OF FEET

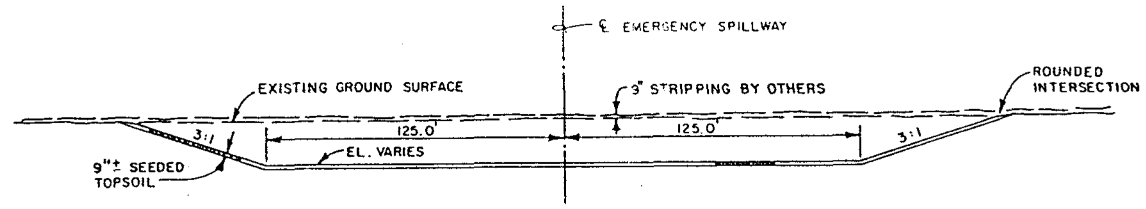


PROFILE ALONG ℄ EMERGENCY SPILLWAY



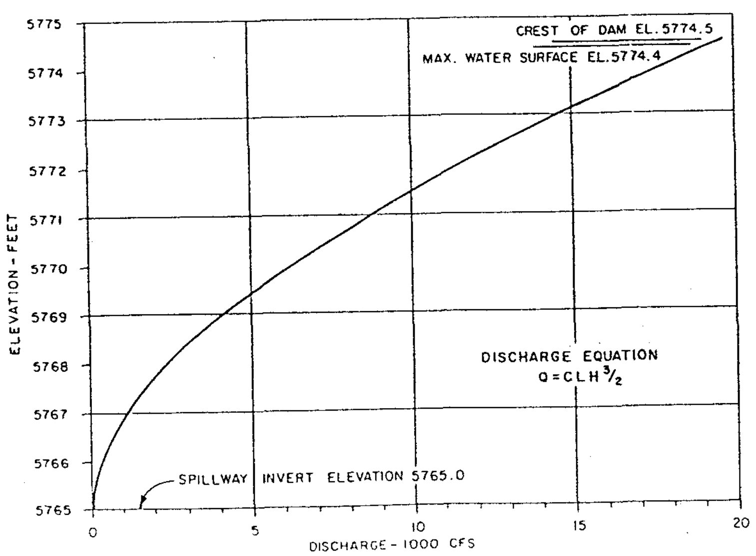
CREST DETAIL AT MAXIMUM CAMBER

3 0 6 12 18
SCALE OF FEET



TYPICAL SECTION - EMERGENCY SPILLWAY

20 0 40 80 120
SCALE OF FEET



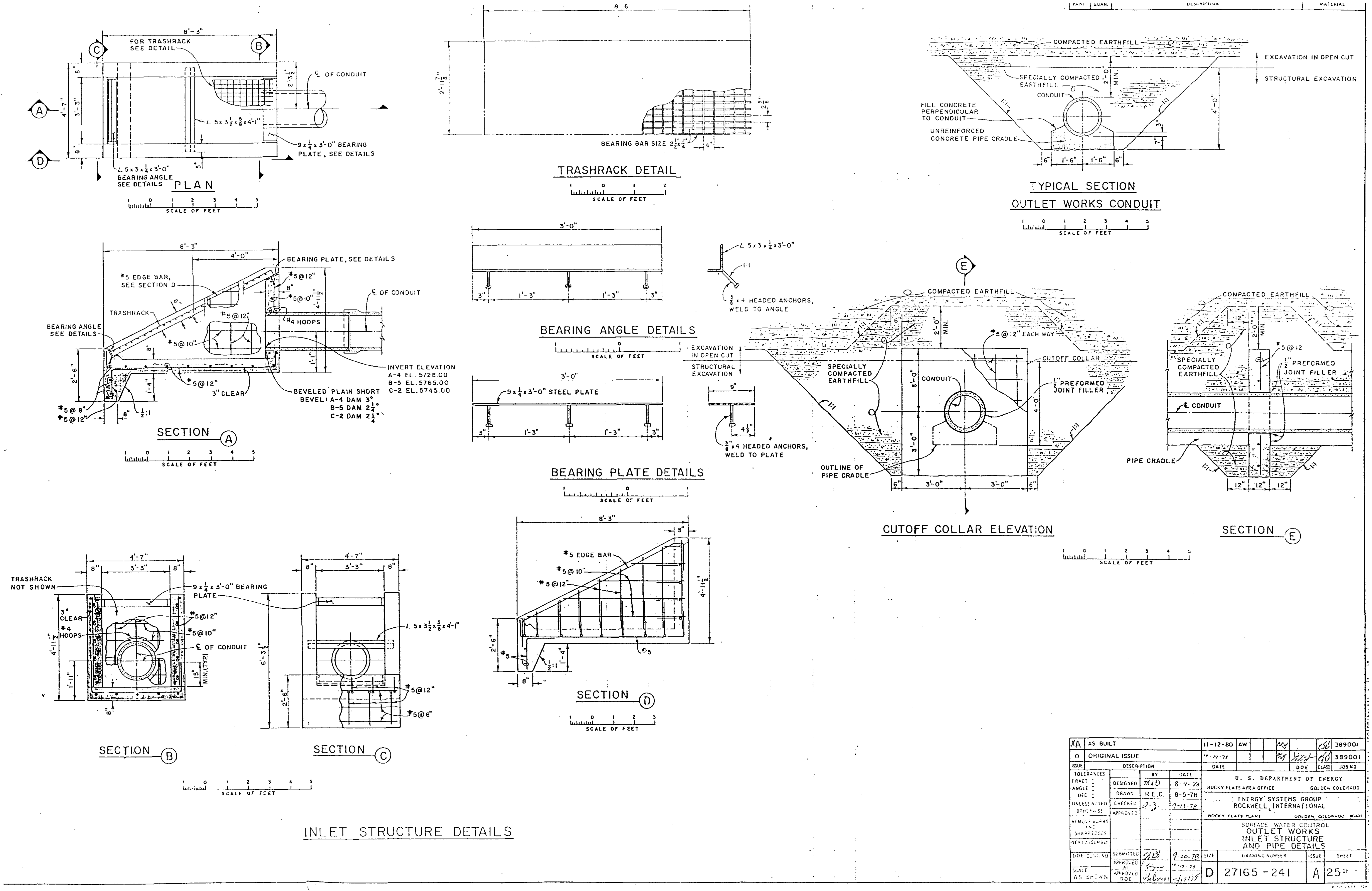
SPILLWAY DISCHARGE CURVE

SYMBOLS

Q = DISCHARGE - C.F.S.
C = COEFFICIENT OF DISCHARGE
L = LENGTH OF SPILLWAY CREST - FEET
H = HEAD - FEET

ISSUE	DESCRIPTION	DATE			DOE	CLASS	JOB NO.
XA	AS BUILT	11-20-79					389001
O	ORIGINAL ISSUE	10-17-78					389001

TOLERANCES FRACT. ± ANGLE ± DEC. ±		BY	DATE	U. S. DEPARTMENT OF ENERGY ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
	DESIGNED	MSD	8-2-78	ENERGY SYSTEMS GROUP ROCKWELL INTERNATIONAL
	DRAWN	H.E.W.	8-6-78	ROCKY FLATS PLANT GOLDEN, COLORADO 80401
UNLESS NOTED OTHERWISE	CHECKED		9-15-78	
	APPROVED			
REMOVE BURRS AND SHARP EDGES				SURFACE WATER CONTROL C-2 DAM - EMBANKMENT AND SPILLWAY DETAILS
NEXT ASSEMBLY				
DOE CONT. NO.	SUBMITTED		9-20-78	SIZE: D DRAWING NUMBER: 27165-235 ISSUE: A SHEET: 22 OF
SCALE AS SHOWN	APPROVED AT		10-17-78	
	APPROVED DOE			



INLET STRUCTURE DETAILS